



December 12, 2012

Mr. Ray Pilapil, Manager
Illinois Environmental Protection Agency
Bureau of Air, Compliance Section #40
1021 North Grand Avenue East
Springfield, II 62702

Re: Annual Compliance Test Report
Flare Performance Testing
Cottonwood Hills Recycling and Disposal Facility

Dear Mr. Pilapil:

Aquaterra Environmental Solutions, Inc. (Aquaterra) on behalf of our client, Waste Management of Illinois, Inc., is submitting the attached report of the *Open Flare Annual Test Report, Cottonwood Hills Recycling and Disposal Facility, Marissa, Illinois* dated December 2012. Please contact us at (618) 628-2001 with any questions or comments regarding this report.

Sincerely,

Aquaterra Environmental Solutions, Inc.

Tia Jeter, P.E.

Project Manager

Andrew Limmer, P.G.

Senior Project Manager

Enclosures

C: Ernest Dennison, P.E. - Waste Management of Illinois, Inc. Kevin Mattison – IEPA Bureau of Air – Des Plaines Office John Justice – IEPA Bureau of Air – Collinsville Office

OPEN FLARE ANNUAL TEST REPORT COTTONWOOD HILLS RECYCLING AND DISPOSAL FACILITY MARISSA, ILLINOIS

Aquaterra Project Number 4733.11

December 2012

Prepared For:

Waste Management of Illinois, Inc. 601 Madison Avenue East St. Louis, Illinois 62201

AQUATERRA

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OPEN FLARE ANNUAL TEST REPORT COTTONWOOD HILLS RECYCLING AND DISPOSAL FACILITY MARISSA, ILLINOIS DECEMBER 2012

1.0 INTRODUCTION

Aquaterra Environmental Solutions, Inc. (Aquaterra) was retained by Waste Management of Illinois, Inc., to perform the 2012 annual sampling of the open flare at the Cottonwood Hills Recycling and Disposal Facility (Cottonwood Hills RDF) located in Marissa, Illinois. The flare testing was performed in accordance with the requirements of the Illinois Environmental Protection Agency (IEPA), New Source Performance Standards (NSPS), and Construction Permit No. 06100058. Tim Pool of Aquaterra performed the Cottonwood Hills RDF flare testing on January 26, 2012 and October 1, 2012.

2.0 FIELD ACTIVITIES

The Cottonwood Hills RDF landfill gas collection and control system is routed to an open landfill gas flare. The open flare is used for the destruction of landfill gas and the control of landfill gas emissions. The flare was installed per Construction Permit No. 06100058 and began operation on February 5, 2008. The flare was continually operated with a flame present at all times during the test period.

Two test events were conducted on the open flare. The test events were completed in January 2012 and October 2012. The visual test of the open flare emissions was conducted during the October 2012 event. Landfill gas samples were collected for laboratory analyses during each test event. Copies of the Cottonwood Hills RDF flare testing field logs are presented in Appendix A. Field testing information including sampling times and flare system performance data are recorded on the field logs.

Samples CWH-4, CWH-5, and CWH-6 were collected on January 26, 2012 and samples CWH #4, CWH #5, and CWH #6 were collected on October 1, 2012. The landfill gas samples were collected under vacuum at the Cottonwood Hills RDF flare inlet using evacuated stainless steel tanks (Summa canisters). A calibrated flow control regulator was used to regulate the flow of landfill gas at the approximate flow rate of 100 milliliters per minute into each evacuated Summa canister. The landfill gas sample canisters were delivered to Columbia Analytical Services (CAS) in Simi Valley, California for laboratory analysis of net heating value, nonmethane organic compounds (NMOCs) and fixed gas analysis per ASTM D3588-98, EPA Method 25C, and EPA Method 3C, respectively. Copies of the laboratory reports are presented in Appendix B.

4733.11\CH 2012 Flare Report 1 **AQUATERRA**

Additional landfill gas samples CWH-1, CWH-2, CWH-3, CWH #1, CWH #2, and CWH #3 were collected on January 26, 2012 and October 1, 2012. These landfill gas samples were collected using 1.0 Liter Zefon bags at the sample port located on the Cottonwood Hills RDF flare inlet. The landfill gas samples were delivered to CAS for analysis of sulfur compounds per ASTM D5504-08. Copies of the laboratory reports are presented in Appendix B.

3.0 ANALYSIS AND RESULTS

The Cottonwood Hills RDF flare testing was performed in accordance with Construction Permit No. 06100058, NSPS, and the relevant guidelines for test methods provided at 40 CFR Part 60, Appendix A. A discussion of the results is provided in the following sections.

3.1 Visible Emissions

Visible emissions (opacity) testing of the Cottonwood Hills RDF flare was performed on October 1, 2012, in accordance with USEPA Method 22, *Determination of Fugitive Emissions from Material Sources and Smoke Emissions from Flares.* The visual emissions from the open flare were continuously monitored for a 2-hour timeframe and documented at 5-minute intervals. A 5-minute rest period occurred after each 20-minute observation period. The Method 22 test result for the Cottonwood Hills RDF flare are summarized on the Method 22 Testing Field Logs presented in Appendix B. The results of the visible emissions test indicated no detectable visible emissions from the Cottonwood Hills RDF flare, therefore, the flare was operated within the maximum permitted emission limit. A summary of the acceptable Cottonwood Hills RDF flare visible emissions testing results is presented as follows.

Actual Visible	Allowable Visible	
Emission Event per 2 hours	Emission Event per 2 hours	
0 seconds	5 minutes	

3.2 Fuel Heating Value

Six of the landfill gas samples collected during the January 2012 and October 2012 events were analyzed for net heating value by ASTM Method D3588 and fixed gases per EPA Method 3C. The results of the laboratory analyses are provided in Appendix B. The laboratory heating value analysis indicated the net heating value of the landfill gas at the time of sample collection was in compliance with the minimum requirements as described in 40 CFR 60.18(c)(3)(ii). The net heating value of the landfill gas during the test events was also calculated based on the concentration of methane in the landfill gas, in accordance with

40 CFR 60.18(f)(3) and 40 CFR 60.754(e). Per 40 CFR 60.754(e), the net heating value of combusted landfill gas is calculated from the concentration of methane in the landfill gas as measured by EPA Method 3C. The measurement of other organic components, hydrogen, and carbon monoxide is not applicable. The results of the net heating value calculation comply with the requirements of 40 CFR 60.18(c)(3)(ii) and not surprisingly are slightly less than the laboratory measured values. This is due to the fact that the calculation considers the heating value of only the methane portion of the landfill gas, while the laboratory analysis considers the heating value of all components of landfill gas contributing to the net heating value, including methane and other organic compounds. Detailed calculations are provided in Appendix C. A summary of the laboratory results, calculated heating values and allowable heating value for the Cottonwood Hills RDF flare is presented in the following table.

Date	Run No.	Laboratory Analytical Heating Value (MJ/scm)	Calculated Heating Value (MJ/scm)	Minimum Allowable Heating Value (MJ/scm)
1/26/2012	CWH-4	17.2	17.1	7.45
1/26/2012	CWH-5	18.0	17.9	7.45
1/26/2012	CWH-6	17.5	17.4	7.45
10/1/2012	CWH #4	16.3	16.1	7.45
10/1/2012	CWH #5	16.3	16.1	7.45
10/1/2012	CWH #6	16.0	15.8	7.45

MJ/scm: Mega joule per standard cubic meter

3.3 Fixed Gas Analysis

Per the requirements of Construction Permit No. 06100058, landfill gas samples collected during the January 2012 and October 2012 events were analyzed for fixed gases, including methane and carbon monoxide, by EPA Method 3C. The results of the analysis, reported as percent by volume (%), are provided in the following table.

Date Collected	1/26/2012			10/1/2012			A
Parameter	CWH-4 CWH-5 CV		CWH-6	CWH #4	CWH #5	CWH #6	Average
Hydrogen	0.8%	0.8%	0.8%	0.7%	0.7%	0.6%	0.7%
Oxygen	1.7%	0.7%	1.3%	1.1%	1.1%	1.5%	1.2%
Nitrogen	11.3%	8.1%	10.1%	13.1%	13%	14.2%	11.6%
Carbon Monoxide	ND	ND	ND	ND	ND	ND	ND
Methane	51.2%	53.5%	52%	48.2%	48.3%	47.4%	50.1%
Carbon Dioxide	35%	36.8%	35.7%	36.8%	36.9%	36.2%	36.2%

ND: Not detected at or above the reporting limit

3.4 NMOC Analysis

Per the requirements of Construction Permit No. 06100058, landfill gas samples collected during the January 2012 and October 2012 events were analyzed for NMOCs by EPA Method 25C. The laboratory results, reported as NMOC (as methane), were converted to NMOC (as hexane), to be consistent with the units reported under NSPS. To convert to the proper units, each NMOC (as methane) result was divided by six. The results of the NMOC(as methane) and calculated NMOC(as hexane) in the samples are summarized in the following table.

Date	Run No.	NMOC (as methane) (ppmv)	NMOC (as hexane) (ppmv)
1/26/12	CWH-4	3,600	600
1/26/12	CWH-5	4,800	800
1/26/12	CWH-6	4,500	750
10/1/12	CWH #4	4,900	817
10/1/12	CWH #5	5,500	917
10/1/12	CWH #6	5,200	867
Average		4,750	790

ppmv: parts per million by volume

3.5 Sulfur Compounds Analysis

A total of six landfill gas samples collected during the January 2012 and October 2012 events were analyzed for twenty sulfur compounds, including hydrogen sulfide, by ASTM Method D 5504-08. The results of the laboratory analyses are provided in Appendix B. The average sulfur content for the samples analyzed was 363.5 ppmv. A summary of the sulfur compounds tested and their concentrations is provided on the table on the following page.

Open Flare Annual Test Report Cottonwood Hills Recycling and Disposal Facility December 2012

Date collected	l loite	1/26/2012			10/1/2012			
Parameter	Units	CWH-1	CWH-2	CWH-3	CWH #1	CWH #2	CWH #3	
Hydrogen Sulfide	ppbv	3,300	16,000	16,000	610,000	710,000	730,000	
Carbonyl Sulfide	ppbv	23	76	76	2,200	210	2,700	
Methyl Mercaptan	ppbv	980	4,100	3,900	10,000	750	12,000	
Ethyl Mercaptan	ppbv	24	97	90	200	16	230	
Dimethyl Sulfide	ppbv	3,000	10,000	9,800	9,500	740	10,000	
Carbon Disulfide	ppbv	14	43	43	1,400	110	1,500	
Isopropyl Mercaptan	ppbv	86	300	280	1,500	120	1,700	
tert-Butyl Mercaptan	ppbv	150	460	420	350	30	380	
n-Propyl Mercaptan	ppbv	14	36	32	88	6.7	100	
Ethyl Methyl Sulfide	ppbv	32	98	86	64	6.2	73	
Thiophene	ppbv	100	350	320	1,600	110	1,800	
Isobutyl Mercaptan	ppbv	30	100	91	ND	ND	ND	
Diethyl Sulfide	ppbv	ND	11	8	10	ND	9.1	
n-Butyl Mercaptan	ppbv	14	52	49	48	ND	48	
Dimethyl Disulfide	ppbv	33	95	83	150	12	150	
3-Methylthiophene	ppbv	28	99	90	71	5.4	75	
Tetrahydrothiophene	ppbv	ND	22	18	22	ND	22	
2,5-Dimethylthiophene	ppbv	ND	11	7.1	26	ND	34	
2-Ethylthiophene	ppbv	ND	11	6.5	8.7	ND	11	
Diethyl Disulfide	ppbv	ND	ND	ND	ND	ND	ND	
Total Per Sample	ppbv	7,828	31,961	31,399.6	637,237.7	712,116.3	760,832.1	
Average	ppmv				363.5			

ppbv: parts per billion by volume ppmv: parts per million by volume

ND: Not detected at or above reporting limit

APPENDIX A

FIELD LOGS



Sampler	Tim Pool				
Date Sample I.D. Vessel I.D. Vessel Vol.	1/26/2012 CWH-1 90675-47506 1.0	ter			
Temperature	Measurements Flare Temp.*	1029	Deg. F		
	Gas Temp.** * Measured with CAT ** Measured with in-I	107.3 123-6700 Infra	Deg. F ired Thermometer	II with Laser Sight	ing
Pressure Mea	surement Static Pressure*_ * Measured with Sho	2.5 rtridge Instrume	Inches H20 ents, Inc. Airdata M	ultimeter ADM 860) #M00577
Flow Rate Re	cord				
	Time Flow Rate* *Recorded from cont	1305 757.9 inuous flowmete	SCFM er		
Summa Canis	ster Vacuum Readings				
	Initial Vacuum Final Vacuum		Inches Hg Inches Hg		
	Start Time _ End Time				

Sampler	Tim Pool				
Date Sample I.D. Vessel I.D. Vessel Vol.	1/26/2012 CWH-2 90675-47503 1.0 lite	er			
Temperature	Measurements Flare Temp.* Gas Temp.**	964 107.8	Deg. F		
	* Measured with CAT ** Measured with in-lin	123-6700 Infra	red Thermomete	r II with Laser Si	ghting
Pressure Mea		2.5 ridge Instrume	Inches H20 ents, Inc. Airdata l	Multimeter ADM	860 #M00577
Flow Rate Re	cord Time Flow Rate* *Recorded from contin	1310 738.2 uous flowmet	- SCFM er		
Summa Canis	ster Vacuum Readings Initial Vacuum Final Vacuum		Inches Hg Inches Hg		
	Start Time End Time		<u>.</u>		

Sampler	Tim Pool	_			
Date Sample I.D. Vessel I.D. Vessel Vol.	1/26/2012 CWH-3 90675-47507 1.0	- - liter			
Temperature M	Flare Temp.*	921	_Deg. F		
	Gas Temp.** * Measured with Ca ** Measured with ir	AT 123-6700 Infr		er II with Laser Sig	hting
Pressure Measu	urement Static Pressure* * Measured with Sh		Inches H20 ents, Inc. Airdata	Multimeter ADM 8	60 #M00577
Flow Rate Reco	ard				
Tiow rate rese	Time Flow Rate* *Recorded from co	1315 835.4 ntinuous flowme	_ SCFM ter		
Summa Caniste	er Vacuum Readings Initial Vacuum Final Vacuum		Inches Hg Inches Hg		
	Start Time End Time		_ _		
	Start Time End Time		_		

Sampler	Tim Pool
Date Sample I.D. Vessel I.D. Vessel Vol.	1/26/2012 CWH-4 1SC00804 1.0 liter
Tomporatura Ma	gauromente
Temperature Me	Flare Temp.*983Deg. F
	Gas Temp.** 106.3 Deg. F
	* Measured with CAT 123-6700 Infrared Thermometer II with Laser Sighting ** Measured with in-line thermometer
	Measured with in-line thermometer
Pressure Measu	
	Static Pressure* 2.5 Inches H20 * Measured with Shortridge Instruments, Inc. Airdata Multimeter ADM 860 #M00577
	Weasured with Shortinge institutions, inc. Alidata Multimeter ADM 000 #1000077
Flow Rate Reco	rd
	Time 1215
	Flow Rate* 839.4 SCFM *Recorded from continuous flowmeter
	Recorded from continuous nowmeter
Summa Canistei	r Vacuum Readings Initial Vacuum -29 Inches Hg
	Final Vacuum -3 Inches Hg
	Charl Time
	Start Time1215 End Time1230

Sampler	Tim Pool			
Date Sample I.D. Vessel I.D. Vessel Vol.	1/26/2012 CWH-5 1SC00766 1.0	liter		
Temperature Me	Flare Temp.* Gas Temp.**	107 C T 123-6700 Infrare	Deg. F Deg. F ed Thermometer II with Laser Sighting	
Pressure Measu	Static Pressure*	2.5 ortridge Instrumen	Inches H20 ts, Inc. Airdata Multimeter ADM 860 #M00	0577
Flow Rate Reco	rd Time	1230		
	Flow Rate* *Recorded from cor	841	SCFM	
Summa Canistei	⁻ Vacuum Readings			
	Initial Vacuum Final Vacuum	-27 -2	Inches Hg Inches Hg	
	Start Time End Time	1230 1246		

Sampler	Tim Pool			
Date Sample I.D. Vessel I.D. Vessel Vol.	1/26/2012 CWH-6 1SC00722 1.0	liter		
Temperature Me	Flare Temp.* Gas Temp.**	108.2 D AT 123-6700 Infrare	reg. F reg. F ed Thermometer II with Laser Sigl	hting
Pressure Measu	Static Pressure*	2.5 ortridge Instrument	Inches H20 ts, Inc. Airdata Multimeter ADM 8	60 #M00577
Flow Rate Reco	rd Time Flow Rate* *Recorded from cor	1246 839.3 ntinuous flowmeter	SCFM	
Summa Caniste	r Vacuum Readings Initial Vacuum Final Vacuum Start Time End Time	-28 -2 1246 1303	Inches Hg Inches Hg	

Sampler	Tim Pool	·	
Date	10/1/2012		
Sample I.D.	CHW #1	•	
/essel I.D.	90675-54833	Flow Controller I.D.	N.
/essel Vol.	1.0	liter bag	
Femperature Me	asurements Flare Temp.*	1251	Dog E
	Gas Temp.**	134	Deg. F
		lare Chart Recorder	Deg. F
	** Measured with in		
	Measured William		
Pressure Measur	rement		
	Static Pressure*	4	Inches H20
	* Measured with Inl	ine Gauge	-
Flow Rate Recor	d		
	Time	1350	
	Flow Rate*	1045	SCFM
	*Recorded from cor	ntinuous flowmeter	
Summa Canister	Vacuum Readings		
	Initial Vacuum	NA	Inches Hg
	Final Vacuum	NA	Inches Hg
	Start Time	NA	
	End Time	NA	

Sampler	Tim Pool	-	
Date Sample I.D. Vessel I.D. Vessel Vol.	10/1/2012 CHW #2 90675-54834 1.0	Flow Controller I.D. liter bag	NA
Temperature Me	easurements		
	Flare Temp.*	1249	Deg. F
	Gas Temp.**	134	Deg. F
	* Recorded From F ** Measured with ir	lare Chart Recorder In-line thermometer	-
Pressure Measu	urement		
	Static Pressure*	4	Inches H20
	* Measured with Inl		•
Flow Rate Reco	ord		
	Time	1355	
	Flow Rate*	1046	SCFM
	*Recorded from co	ntinuous flowmeter	•
Summa Caniste	r Vacuum Readings	•	
	initial Vacuum	NA	Inches Hg
	Final Vacuum	NA	Inches Hg
	Start Time	NA	
	End Time	NA	-

Sampler	Tim Pool	_	
Date	10/1/2012		
Sample I.D.	CHW #3	-	
Vessel I.D.	90675-54836	Flow Controller I.D.	NA
Vessel Vol.	1.0	liter bag	
			•
Temperature Me	easurements		
	Flare Temp.*	1238	Deg. F
	Gas Temp.**	134	Deg. F
	* Recorded From F	lare Chart Recorder	•
-	** Measured with in	-line thermometer	
Pressure Measu	ırement		
	Static Pressure*	. 4	Inches H20
	* Measured with Inl	ine Gauge	
Flow Rate Reco	rd		
	Time	1400	
	Flow Rate*	1042	SCFM
	*Recorded from co	ntinuous flowmeter	-
Summa Caniste	r Vacuum Readings		
	Initial Vacuum	NA	Inches Hg
	Final Vacuum	NA	Inches Hg
	Start Time	NA ·	
	End Time	NA NA	

Sampler	Tim Pool		
Date Sample I.D. Vessel I.D. Vessel Vol.	10/1/2012 CHW #4 1SC00442 1.0	Flow Controller I.D.	AVG02580
Temperature Me	asurements		
	Flare Temp.*	1199	Deg. F
	Gas Temp.**		Deg. F
	* Recorded From F ** Measured with in	are Chart Recorder -line thermometer	
Pressure Measu	rement		•
	Static Pressure* * Measured with Inl	4 ine Gauge	Inches H20
Flow Rate Recor	⁻ d		
	Time	1405	
	Flow Rate*	1043	SCFM
	*Recorded from cor	ntinuous flowmeter	-
Summa Canister	Vacuum Readings		
	Initial Vacuum	-27	Inches Hg
	Final Vacuum	-1	Inches Hg
	Start Time	1405	
	End Time	1413	_

Sampler	Tim Pool		
Date	10/1/2012		
Sample I.D.	CHW #5	•	
Vessel I.D.	1SC00388	Flow Controller I.D.	AVG01382
Vessel Vol.	1.0	liter	
Tamananah wa Bila			
Temperature Me	asurements Flare Temp.*	1200	Dog E
		1200	Deg. F
	Gas Temp.**		Deg. F
		lare Chart Recorder	
	** Measured with in	-iine thermometer	
Pressure Measu	rement		
TODOGIO MICCO	Static Pressure*	4	Inches H20
	* Measured with Inl		- 111011031120
	Wicadarda With Iti	ino Oddge	
Flow Rate Recor	rd		
	Time	1415	
	Flow Rate*	1043	SCFM
	*Recorded from cor	ntinuous flowmeter	
Summa Canister	Vacuum Readings		
	Initial Vacuum	-27	Inches Hg
	Final Vacuum	-1	Inches Hg
	Start Time	4445	
	End Time	1415 1425	-
	Enu rine	1420	•

Sampler	Tim Pool		
Date Sample I.D. Vessel I.D. Vessel Vol.	10/1/2012 CHW #6 1SC00364 1.0	Flow Controller I.D.	AVG02399
Temperature Me	asurements Flare Temp.* Gas Temp.**	1204 134	_Deg. F Deg. F
	* Recorded From Fl ** Measured with in	are Chart Recorder -line thermometer	
Pressure Measu	rement Static Pressure* * Measured with Inl		Inches H20
Flow Rate Recor			
	Time Flow Rate* *Recorded from cor	1430 1042 ntinuous flowmeter	SCFM
Summa Canister	· Vacuum Readings		
	Initial Vacuum Final Vacuum	-27 -2	Inches Hg Inches Hg
	Start Time	1430 .	-
	End Time	1441	_

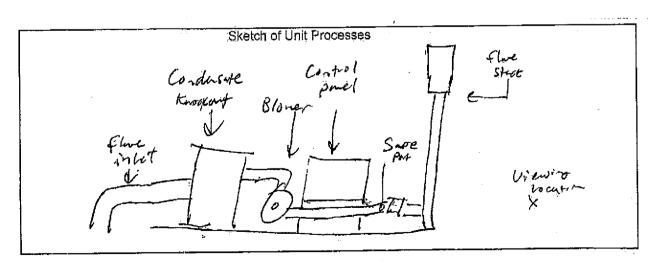
AQUATERRA ENVIRONMENTAL SOLUTIONS, INC.

LANDFILL GAS FLARE TESTING LOG VISIBLE EMISSIONS INSPECTION - METHOD 22

Cottonwood Hills Recycling and DisposalFacility Marissa, Illinois

Tester	Tim Pool		Date	10/1/2012	
Time	Elapsed Time	Accumulate Emissions	Time	Elapsed Time	Accumulate Emissions
(Hour:Min.)	(Minutes)	(Min.:Sec.)	(Hour:Min.)	(Minutes)	(Min.:Sec.)
1115	0		1230	60	
1120	5	0:00	1235	65	0:00
1125	10	0:00	1240	70	0:00
1130	15	0:00	1245	75	0:00
1135	20	0:00	1250	80	0:00
7000 1250	100				
1140	20		1255	80	
1145	25	0:00	1300	85	0:00
1150	30	0:00	1305	90	0:00
1155	35	0:00	1310	95	0:00
1200	40	0:00	1315	100	0:00
		的過程可以可能			
1205	40		1320	100	
1210	45	0:00	1325_	105	0:00
1215	50	0:00	1330	110	0:00
1220	55	0:00	1335	115	0:00
· 1225	60	0:00	1340	120	0:00
	First Hour Subtotal:	0:0		Second Hour Subtotal:	0:00
		Total Visib	le Emissions		0:00

Notes:



APPENDIX B LABORATORY REPORTS



HEATING VALUE, FIXED GASES, AND NMOC ANALYSIS



Columbia



Analytical Services

LABORATORY REPORT

February 10, 2012

Tim Pool Aquaterra Environmental Solutions, Inc. 13 Executive Dr., Suite 1 Fairview Heights, IL 62208

RE: Cottonwood Hills Flare Gas Sample / 4733.11

Dear Tim:

Enclosed are the results of the samples submitted to our laboratory on January 31, 2012. For your reference, these analyses have been assigned our service request number P1200364.

All analyses were performed according to our laboratory's NELAP and DoD-ELAP-approved quality assurance program. The test results meet requirements of the current NELAP and DoD-ELAP standards, where applicable, and except as noted in the laboratory case narrative provided. For a specific list of NELAP and DoD-ELAPaccredited analytes, refer to the certifications section at www.caslab.com. Results are intended to be considered in their entirety and apply only to the samples analyzed and reported herein.

Columbia Analytical Services, Inc. is certified by the California Department of Health Services, NELAP Laboratory Certificate No. 02115CA; Arizona Department of Health Services, Certificate No. AZ0694; Florida Department of Health, NELAP Certification E871020; New Jersey Department of Environmental Protection, NELAP Laboratory Certification ID #CA009; New York State Department of Health, NELAP NY Lab ID No: 11221; Oregon Environmental Laboratory Accreditation Program, NELAP ID: CA20007; The American Industrial Hygiene Association, Laboratory #101661; United States Department of Defense Environmental Laboratory Accreditation Program (DoD-ELAP), Certificate No. L10-3-R2; Pennsylvania Registration No. 68-03307; TX Commission of Environmental Quality, NELAP ID T104704413-11-2; Minnesota Department of Health, NELAP Certificate No. 362188; Washington State Department of Ecology, ELAP Lab ID: C946, State of Utah Department of Health, NELAP Certificate No. CA015272011-1; Los Angeles Department of Building and Safety, Approval No: TA00001. Each of the certifications listed above have an explicit Scope of Accreditation that applies to specific matrices/methods/analytes; therefore, please contact me for information corresponding to a particular certification.

If you have any questions, please call me at (805) 526-7161.

Respectfully submitted,

Columbia Analytical Services, Inc.

Sue Anderson Project Manager





Client: Aquaterra Environmental Solutions, Inc. CAS Project No: P1200364

Cottonwood Hills Flare Gas Sample / 4733.11 Project:

CASE NARRATIVE

The samples were received intact under chain of custody on January 31, 2012 and were stored in accordance with the analytical method requirements. Please refer to the sample acceptance check form for additional information. The results reported herein are applicable only to the condition of the samples at the time of sample receipt.

BTU and CHONS Analysis

The results for BTU and CHONS were generated according to ASTM D 3588-98. The following analyses were performed and used to calculate the BTU and CHONS results.

C2 through C6 Hydrocarbon Analysis

The samples were analyzed according to modified EPA Method TO-3 for C2 through >C6 hydrocarbons using a gas chromatograph equipped with a flame ionization detector (FID).

Fixed Gases Analysis

The samples were also analyzed for fixed gases (hydrogen, oxygen/argon, nitrogen, carbon monoxide, methane and carbon dioxide) according to modified EPA Method 3C (single injection) using a gas chromatograph equipped with a thermal conductivity detector (TCD).

Hydrogen Sulfide Analysis

The samples were also analyzed for hydrogen sulfide per ASTM D 5504-08 using a gas chromatograph equipped with a sulfur chemiluminescence detector (SCD).

Total Gaseous Non-Methane Organics as Methane Analysis

The samples were analyzed for total gaseous non-methane organics as methane according to modified EPA Method 25C. The analyses included a single sample injection (method modification) analyzed by gas chromatography using flame ionization detection/total combustion analysis.

The results of analyses are given in the attached laboratory report. All results are intended to be considered in their entirety, and Columbia Analytical Services, Inc. (CAS) is not responsible for utilization of less than the complete report.

Use of Columbia Analytical Services, Inc. (CAS) Name, Client shall not use CAS's name or trademark in any marketing or reporting materials, press releases or in any other manner ("Materials") whatsoever and shall not attribute to CAS any test result, tolerance or specification derived from CAS's data ("Attribution") without CAS's prior written consent, which may be withheld by CAS for any reason in its sole discretion. To request CAS's consent, Client shall provide copies of the proposed Materials or Attribution and describe in writing Client's proposed use of such Materials or Attribution. If CAS has not provided written approval of the Materials or Attribution within ten (10) days of receipt from Client, Client's request to use CAS's name or trademark in any Materials or Attribution shall be deemed denied. CAS may, in its discretion, reasonably charge Client for its time in reviewing Materials or Attribution requests. Client acknowledges and agrees that the unauthorized use of CAS's name or trademark may cause CAS to incur irreparable harm for which the recovery of money damages will be inadequate. Accordingly, Client acknowledges and agrees that a violation shall justify preliminary injunctive relief. For questions contact the laboratory.



Now part of the

DETAIL SUMMARY REPORT

Container

ID

1SC00804

1SC00766

1SC00722

Pi1

(psig)

-0.24

0.03

0.01

Pf1

(psig)

6.60

5.81

6.42

Time

Collected

12:15

12:30

12:46

Date

Collected

1/26/2012

1/26/2012

1/26/2012

Matrix

Air

Air

Air

Client: Aquaterra Environmental Solutions, Inc.

Lab Code

P1200364-001

P1200364-002

P1200364-003

Project ID: Cottonwood Hills Flare Gas Sample / 4733.11

Date Received: 1/31/2012 Time Received: 09:10

Client Sample ID

CWH-4

CWH-5

CWH-6

Service Request: P1200364

X X X X

X = X

X = X

X



Air - Chain of Custody Record & Analytical Service Request

Page	of
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2655 Park Center Drive, Suite A Simi Valley, California 93065 Phone (805) 526-7161 Fay (805) 526-7270

Phone (805) 526-7161 Fax (805) 526-7270				Requested Turnard					iard	CAS Project	No. 00364	-
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RSK - MEEPP, HCL (pH<2); RSK - CO2, (pH 5-8); Sulfur (pH>4)

Now	part of the ALS	iraup	Samul	le Acceptance	Check Forn					
Client:	Aquaterra Env	rironmental Solutions	_	ic Acceptance	CHECK FOIL		P1200364			
Project:	Cottonwood H	Iills Flare Gas Sample	2 / 4733.11		*					
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1	Were sample	containers properly n	narked with cl	lient sample ID)?			×		
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3	Did sample co	ontainers arrive in go	od condition?					X		
4	Were chain-or	f-custody papers used	and filled out	t?				X		
5	Did sample container labels and/or tags agree with custody papers? $\ \square$									
6	Was sample volume received adequate for analysis?									
7	Are samples within specified holding times?									
8	Was proper te	mperature (thermal p	preservation) o	of cooler at rec	eipt adhered	to?				X
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RESULTS OF ANALYSIS

Page 1 of 1

Client: Aquaterra Environmental Solutions, Inc.

Client Sample ID: CWH-4 CAS Project ID: P1200364 Client Project ID: Cottonwood Hills Flare Gas Sample / 4733.11 CAS Sample ID: P1200364-001

Test Code: ASTM D3588-98

Analyst: Dante Munoz-Castaneda/Lauryn Keeler Date Collected: 1/26/12 Sampling Media: 1.0 L Summa Canister Date Received: 1/31/12

Test Notes:

Container ID: 1SC00804

> Initial Pressure (psig): -0.24 Final Pressure (psig): 6.60

		Canister Dilution Factor: 1.47			
Components	Result	Result	Data		
•	Volume %	Weight %	Qualifier		
Hydrogen	0.76	0.06	-		
Oxygen + Argon	1.68	1.96			
Nitrogen	11.33	11.59			
Carbon Monoxide	< 0.01	< 0.01			
Methane	51.17	29.98			
Carbon Dioxide	35.03	56.32			
Hydrogen Sulfide	< 0.01	< 0.01			
Ethane	< 0.01	< 0.01			
Propane	< 0.01	< 0.01			
Butanes	< 0.01	< 0.01			
Pentanes	< 0.01	0.01			
Hexanes	< 0.01	0.01			
> Hexanes	< 0.01	0.04			
TOTALS	99.99	99.99			
Components	Mole %	Weight %			
Carbon	22.19	37.88			
Hydrogen	53.11	7.61			
Oxygen + Argon	18.88	42.92			
Nitrogen	5.83	11.60			
Sulfur	< 0.10	< 0.10			
Specific Gravity (Air = 1)		0.9451			
Specific Volume	ft3/lb	13.86			
Gross Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/ft3	521.9			
Net Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/ft3	469.8			
Gross Heating Value (Water Saturated at 0.25636 psia)	BTU/ft3	511.4			
Net Heating Value (Water Saturated at 0.25636 psia)	BTU/ft3	460.4			
Gross Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/lb	7,235.3			
		*			

Net Heating Value (Dry Gas @ 60 F, 14.696 psia)

Compressibility Factor "Z" (60 F, 14.696 psia)

6,513.1

0.9973

BTU/lb



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RESULTS OF ANALYSIS

Page 1 of 1

Client: Aquaterra Environmental Solutions, Inc.

Client Sample ID: CWH-5 CAS Project ID: P1200364 Client Project ID: Cottonwood Hills Flare Gas Sample / 4733.11 CAS Sample ID: P1200364-002

Test Code: ASTM D3588-98

Analyst: Dante Munoz-Castaneda/Lauryn Keeler Date Collected: 1/26/12 Sampling Media: 1.0 L Summa Canister Date Received: 1/31/12

Test Notes:

Container ID: 1SC00766

> Initial Pressure (psig): 0.03 Final Pressure (psig): 5.81

		Canister Dilution	Canister Dilution Factor: 1.39	
Components	Result	Result	Data	
-	Volume %	Weight %	Qualifier	
Hydrogen	0.82	0.06	-	
Oxygen + Argon	0.74	0.87		
Nitrogen	8.11	8.31		
Carbon Monoxide	< 0.01	< 0.01		
Methane	53.50	31.40		
Carbon Dioxide	36.77	59.21		
Hydrogen Sulfide	< 0.01	< 0.01		
Ethane	< 0.01	< 0.01		
Propane	< 0.01	< 0.01		
Butanes	< 0.01	< 0.01		
Pentanes	< 0.01	0.02		
Hexanes	< 0.01	0.02		
> Hexanes	0.02	0.08		
TOTALS	99.99	99.99		
Components	Mole %	Weight %		
Carbon	22.73	39.77		
Hydrogen	54.34	7.98		
Oxygen + Argon	18.85	43.94		
Nitrogen	4.08	8.32		
Sulfur	< 0.10	< 0.10		
Specific Gravity (Air = 1)		0.9437		
Specific Volume	ft3/lb	13.88		
Gross Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/ft3	546.7		
Net Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/ft3	492.2		
Gross Heating Value (Water Saturated at 0.25636 psia)	BTU/ft3	535.7		
Net Heating Value (Water Saturated at 0.25636 psia)	BTU/ft3	482.2		
Gross Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/lb	7,591.0		
Net Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/lb	6,833.6		
Compressibility Factor "Z" (60 F, 14.696 psia)		0.9972		





RESULTS OF ANALYSIS

Page 1 of 1

Client: Aquaterra Environmental Solutions, Inc.

Client Sample ID: CWH-6 CAS Project ID: P1200364 Client Project ID: Cottonwood Hills Flare Gas Sample / 4733.11 CAS Sample ID: P1200364-003

Test Code: ASTM D3588-98

Analyst: Dante Munoz-Castaneda/Lauryn Keeler Date Collected: 1/26/12 Sampling Media: 1.0 L Summa Canister Date Received: 1/31/12

Test Notes:

Container ID: 1SC00722

> Initial Pressure (psig): 0.01 Final Pressure (psig): 6.42

		Canister Dilution Factor: 1.44	
Components	Result	Result	Data
	Volume %	Weight %	Qualifier
Hydrogen	0.79	0.06	
Oxygen + Argon	1.31	1.53	
Nitrogen	10.11	10.34	
Carbon Monoxide	< 0.01	< 0.01	
Methane	52.03	30.50	
Carbon Dioxide	35.71	57.43	
Hydrogen Sulfide	< 0.01	< 0.01	
Ethane	< 0.01	< 0.01	
Propane	< 0.01	< 0.01	
Butanes	< 0.01	< 0.01	
Pentanes	< 0.01	0.02	
Hexanes	< 0.01	0.02	
> Hexanes	0.02	0.07	
TOTALS	99.99	99.99	

Components	Mole %	Weight %	
Carbon	22.40	38.60	
Hydrogen	53.58	7.75	
Oxygen + Argon	18.87	43.30	
Nitrogen	5.15	10.35	
Sulfur	< 0.10	< 0.10	

Specific Gravity (Air = 1)		0.9448	
Specific Volume	ft3/lb	13.87	
Gross Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/ft3	531.4	
Net Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/ft3	478.4	
Gross Heating Value (Water Saturated at 0.25636 psia)	BTU/ft3	520.7	
Net Heating Value (Water Saturated at 0.25636 psia)	BTU/ft3	468.8	
Gross Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/lb	7,369.7	
Net Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/lb	6,634.3	
Compressibility Factor "Z" (60 F, 14.696 psia)		0.9973	

Volume(s) Analyzed:

 $0.10 \, \text{ml(s)}$





RESULTS OF ANALYSIS

Page 1 of 1

Client: Aquaterra Environmental Solutions, Inc.

Client Sample ID: CWH-4 CAS Project ID: P1200364 Client Project ID: Cottonwood Hills Flare Gas Sample / 4733.11 CAS Sample ID: P1200364-001

Test Code: EPA Method 3C Modified Date Collected: 1/26/12 HP5890 II/GC1/TCD Instrument ID: Date Received: 1/31/12 Analyst: Dante Munoz-Castaneda Date Analyzed: 2/3/12

Sampling Media: 1.0 L Summa Canister

Test Notes:

Container ID: 1SC00804

> Initial Pressure (psig): Final Pressure (psig): 6.60 -0.24

> > Canister Dilution Factor: 1.47

CAS#	Compound	Result	MRL	Data
		%, v/v	%, v/v	Qualifier
1333-74-0	Hydrogen	0.765	0.15	
7782-44-7	Oxygen +			
7440-37-1	Argon	1.68	0.15	
7727-37-9	Nitrogen	11.3	0.15	
630-08-0	Carbon Monoxide	ND	0.15	
74-82-8	Methane	51.2	0.15	
124-38-9	Carbon Dioxide	35.0	0.15	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.





RESULTS OF ANALYSIS

Page 1 of 1

Client: Aquaterra Environmental Solutions, Inc.

Client Sample ID: CWH-5 CAS Project ID: P1200364 Client Project ID: Cottonwood Hills Flare Gas Sample / 4733.11 CAS Sample ID: P1200364-002

Test Code: EPA Method 3C Modified Date Collected: 1/26/12 HP5890 II/GC1/TCD Instrument ID: Date Received: 1/31/12 Analyst: Dante Munoz-Castaneda Date Analyzed: 2/3/12

Sampling Media: Volume(s) Analyzed: 1.0 L Summa Canister $0.10 \, \text{ml(s)}$

Test Notes:

Container ID: 1SC00766

> Initial Pressure (psig): Final Pressure (psig): 5.81 0.03

> > Canister Dilution Factor: 1.39

CAS#	Compound	Result	MRL	Data
		%, v/v	$\%$, $_{ m V/V}$	Qualifier
1333-74-0	Hydrogen	0.820	0.14	
7782-44-7	Oxygen +			
7440-37-1	Argon	0.741	0.14	
7727-37-9	Nitrogen	8.11	0.14	
630-08-0	Carbon Monoxide	ND	0.14	
74-82-8	Methane	53.5	0.14	
124-38-9	Carbon Dioxide	36.8	0.14	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.



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RESULTS OF ANALYSIS

Page 1 of 1

Client: Aquaterra Environmental Solutions, Inc.

Client Sample ID: CWH-6 CAS Project ID: P1200364 Client Project ID: Cottonwood Hills Flare Gas Sample / 4733.11 CAS Sample ID: P1200364-003

Test Code: EPA Method 3C Modified Date Collected: 1/26/12 HP5890 II/GC1/TCD Instrument ID: Date Received: 1/31/12 Analyst: Dante Munoz-Castaneda Date Analyzed: 2/3/12

Sampling Media: Volume(s) Analyzed: 1.0 L Summa Canister $0.10 \, \text{ml(s)}$

Test Notes:

Container ID: 1SC00722

> Initial Pressure (psig): 0.01 Final Pressure (psig): 6.42

> > Canister Dilution Factor: 1.44

CAS#	Compound	Result	MRL	Data
		%, v/v	$\%$, $_{ m V/V}$	Qualifier
1333-74-0	Hydrogen	0.794	0.14	
7782-44-7	Oxygen +			
7440-37-1	Argon	1.31	0.14	
7727-37-9	Nitrogen	10.1	0.14	
630-08-0	Carbon Monoxide	ND	0.14	
74-82-8	Methane	52.0	0.14	
124-38-9	Carbon Dioxide	35.7	0.14	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.



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Analytical Services

RESULTS OF ANALYSIS

Page 1 of 1

Client: Aquaterra Environmental Solutions, Inc.

Client Sample ID: Method Blank CAS Project ID: P1200364 Client Project ID: Cottonwood Hills Flare Gas Sample / 4733.11 CAS Sample ID: P120203-MB

Test Code: EPA Method 3C Modified Date Collected: NA HP5890 II/GC1/TCD Instrument ID: Date Received: NA Analyst: Dante Munoz-Castaneda Date Analyzed: 2/03/12

Sampling Media: Volume(s) Analyzed: 1.0 L Summa Canister $0.10 \, \text{ml(s)}$

Test Notes:

CAS#	Compound	Result	MRL	Data
		%, v/v	%, V/V	Qualifier
1333-74-0	Hydrogen	NE	0.10	
7782-44-7	Oxygen +			
7440-37-1	Argon	ND	0.10	
7727-37-9	Nitrogen	ND	0.10	
630-08-0	Carbon Monoxide	ND	0.10	
74-82-8	Methane	ND	0.10	
124-38-9	Carbon Dioxide	ND	0.10	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.





Columbia Analytical Services*

LABORATORY CONTROL SAMPLE SUMMARY

Page 1 of 1

Client: Aquaterra Environmental Solutions, Inc.

Client Sample ID: Lab Control Sample CAS Project ID: P1200364 Client Project ID: Cottonwood Hills Flare Gas Sample / 4733.11 CAS Sample ID: P120203-LCS

Test Code: EPA Method 3C Modified Date Collected: NA HP5890 II/GC1/TCD Date Received: NA Instrument ID: Dante Munoz-Castaneda Date Analyzed: 2/03/12 Analyst:

Sampling Media: 1.0 L Summa Canister Volume(s) Analyzed: NA ml(s)

					CAS	
CAS#	Compound	Spike Amount	Result	% Recovery	Acceptance	Data
		ppmV	ppmV		Limits	Qualifier
1333-74-0	Hydrogen	40,300	38,500	96	83-122	
7782-44-7	Oxygen +					
7440-37-1	Argon	50,000	49,800	100	74-132	
7727-37-9	Nitrogen	49,800	51,200	103	76-126	
630-08-0	Carbon Monoxide	49,900	50,500	101	84-113	
74-82-8	Methane	40,300	41,700	103	84-113	
124-38-9	Carbon Dioxide	50,000	50,200	100	87-117	





Page 1 of 1

Client: Aquaterra Environmental Solutions, Inc. Client Project ID: Cottonwood Hills Flare Gas Sample / 4733.11

CAS Project ID: P1200364

Total Gaseous Nonmethane Organics (TGNMO) as Methane

Test Code:

EPA Method 25C Modified

Instrument ID:

HP5890 II/GC1/FID/TCA

Analyst:

Sampling Media:

Lauryn Keeler

1.0 L Summa Canister(s)

Date(s) Collected: 1/26/12

Date Received: 1/31/12

Date Analyzed: 2/2 - 2/10/12

Client Sample ID	CAS Sample ID	Canister Dilution Factor	Injection Volume ml(s)	Result ppmV	MRL ppmV	Data Qualifier
CWH-4	P1200364-001	1.47	0.50	3,600	1.5	
CWH-5	P1200364-002	1.39	0.50	4,800	1.4	
CWH-6	P1200364-003	1.44	0.50	4,500	1.4	
Method Blank	P120202-MB	1.00	0.50	ND	1.0	
Method Blank	P120210-MB	1.00	0.50	ND	1.0	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.





LABORATORY CONTROL SAMPLE SUMMARY

Page 1 of 1

Client: Aquaterra Environmental Solutions, Inc.

Client Sample ID: Lab Control Sample CAS Project ID: P1200364 Client Project ID: Cottonwood Hills Flare Gas Sample / 4733.11 CAS Sample ID: P120202-LCS

Date Collected: NA Test Code: EPA Method 25C Modified Instrument ID: HP5890 II/GC1/FID/TCA Date Received: NA Lauryn Keeler Analyst: Date Analyzed: 2/02/12

Sampling Media: 1.0 L Summa Canister Volume(s) Analyzed: NA ml(s)

Test Notes:

				CAS	
Compound	Spike Amount	Result	% Recovery	Acceptance	Data
	ppmV	ppmV		Limits	Qualifier
Total Gaseous Nonmethane Organics (TGNMO) as Methane	98.8	118	119	71-136	

25C_ALL.XLT - Page No.: P1200364_25C_1202061655_SS.xls - LCS 15 of 16





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LABORATORY CONTROL SAMPLE SUMMARY

Page 1 of 1

Client: Aquaterra Environmental Solutions, Inc.

Client Sample ID: Lab Control Sample CAS Project ID: P1200364 Client Project ID: Cottonwood Hills Flare Gas Sample / 4733.11 CAS Sample ID: P120210-LCS

EPA Method 25C Modified Test Code: Date Collected: NA Instrument ID: HP5890 II/GC1/FID/TCA Date Received: NA Dante Munoz-Castaneda Analyst: Date Analyzed: 2/10/12

Sampling Media: 1.0 L Summa Canister Volume(s) Analyzed: NA ml(s)

				CAS	
Compound	Spike Amount	Result	% Recovery	Acceptance	Data
	ppmV	ppmV		Limits	Qualifier
Total Gaseous Nonmethane Organics (TGNMO) as Methane	98.8	114	115	71-136	





LABORATORY REPORT

October 10, 2012

Analytical Services*

Tim Pool Aquaterra Environmental Solutions, Inc. 13 Executive Dr., Suite 1 Fairview Heights, IL 62208

RE: Cottonwood Hills 2012 Flare Testing / 4733.11

Dear Tim:

Enclosed are the results of the samples submitted to our laboratory on October 4, 2012. For your reference, these analyses have been assigned our service request number P1204087.

All analyses were performed according to our laboratory's NELAP and DoD-ELAP-approved quality assurance program. The test results meet requirements of the current NELAP and DoD-ELAP standards, where applicable, and except as noted in the laboratory case narrative provided. For a specific list of NELAP and DoD-ELAP-accredited analytes, refer to the certifications section at www.caslab.com. Results are intended to be considered in their entirety and apply only to the samples analyzed and reported herein.

Columbia Analytical Services, Inc. dba ALS Environmental (ALS) is certified by the California Department of Health Services, NELAP Laboratory Certificate No. 02115CA; Arizona Department of Health Services, Certificate No. AZ0694; Florida Department of Health, NELAP Certification E871020; New Jersey Department of Environmental Protection, NELAP Laboratory Certification ID #CA009; New York State Department of Health, NELAP NY Lab ID No: 11221; Oregon Environmental Laboratory Accreditation Program, NELAP ID: CA200007; The American Industrial Hygiene Association, Laboratory #101661; United States Department of Defense Environmental Laboratory Accreditation Program (DoD-ELAP), Certificate No. L11-203; Pennsylvania Registration No. 68-03307; TX Commission of Environmental Quality, NELAP ID T104704413-12-3; Minnesota Department of Health, NELAP Certificate No. 362188; Washington State Department of Ecology, ELAP Lab ID: C946, State of Utah Department of Health, NELAP Certificate No. CA01527Z012-Z; Los Angeles Department of Building and Safety, Approval No: TA00001. Each of the certifications listed above have an explicit Scope of Accreditation that applies to specific matrices/methods/analytes; therefore, please contact me for information corresponding to a particular certification.

If you have any questions, please call me at (805) 526-7161.

Respectfully submitted,

ALS | Environmental

Sue Anderson Project Manager





Client Aguaterra Environmental Solutions, Inc. Service Request No: P1204087

Project: Cottonwood Hills 2012 Flare Testing / 4733.11

CASE NARRATIVE

The samples were received intact under chain of custody on October 4, 2012 and were stored in accordance with the analytical method requirements. Please refer to the sample acceptance check form for additional information. The results reported herein are applicable only to the condition of the samples at the time of sample receipt.

BTU and CHONS Analysis

The results for BTU and CHONS were generated according to ASTM D 3588-98. The following analyses were performed and used to calculate the BTU and CHONS results.

C2 through C6 Hydrocarbon Analysis

The samples were analyzed according to modified EPA Method TO-3 for C₂ through >C₆ hydrocarbons using a gas chromatograph equipped with a flame ionization detector (FID).

Fixed Gases Analysis

The samples were also analyzed for fixed gases (hydrogen, oxygen/argon, nitrogen, carbon monoxide, methane and carbon dioxide) according to ASTM D 1946 using a gas chromatograph equipped with a thermal conductivity detector (TCD).

Hydrogen Sulfide Analysis

The were also analyzed for hydrogen sulfide per ASTM D 5504-08 using a gas chromatograph equipped with a sulfur chemiluminescence detector (SCD).

Total Gaseous Non-Methane Organics as Methane Analysis

The samples were also analyzed for total gaseous non-methane organics as methane according to modified EPA Method 25C. The analyses included a single sample injection (method modification) analyzed by gas chromatography using flame ionization detection/total combustion analysis.

The results of analyses are given in the attached laboratory report. All results are intended to be considered in their entirety, and Columbia Analytical Services, Inc. dba ALS Environmental (ALS) is not responsible for utilization of less than the complete report.

Use of Columbia Analytical Services. Inc. dba ALS Environmental (ALS)'s Name. Client shall not use ALS's name or trademark in any marketing or reporting materials, press releases or in any other manner ("Materials") whatsoever and shall not attribute to AALS any test result, tolerance or specification derived from ALS's data ("Attribution") without ALS's prior written consent, which may be withheld by ALS for any reason in its sole discretion. To request ALS's consent, Client shall provide copies of the proposed Materials or Attribution and describe in writing Client's proposed use of such Materials or Attribution. If ALS has not provided written approval of the Materials or Attribution within ten (10) days of receipt from Client, Client's request to use ALS's name or trademark in any Materials or Attribution shall be deemed denied. ALS may, in its discretion, reasonably charge Client for its time in reviewing Materials or Attribution requests. Client acknowledges and agrees that the unauthorized use of ALS's name or trademark may cause ALS to incur irreparable harm for which the recovery of money damages will be inadequate. Accordingly, Client acknowledges and agrees that a violation shall justify preliminary injunctive relief. For questions contact the laboratory.



Now part of the

DETAIL SUMMARY REPORT

Container

ID

1SC00442

1SC00388

1SC00364

Pi1

(psig)

-0.98

-1.47

-1.59

Pf1

(psig)

6.52

5.34

5.05

Date

Collected

10/1/2012

10/1/2012

10/1/2012

Matrix

Air

Air

Air

Time

Collected

14:05

14:15

14:30

Client: Aquaterra Environmental Solutions, Inc.

Lab Code

P1204087-001

P1204087-002

P1204087-003

Project ID: Cottonwood Hills 2012 Flare Testing / 4733.11

Date Received: Time Received:

Client Sample ID

CWH #4

CWH #5

CWH #6

10/4/2012 09:15

Service Request: P1204087

TO-3 Modified - C1C6+	X 3C Modified - Fxd Gases	× ASTM D5504-01 - H2S	25C Modified - TGNMO+ 13	
\mathbf{X}	X	X	X	
X	X	X	X	

X X

X



WM00655

Air - Chain of Custody Record & Analytical Service Request

Page		of		
, ago	************		***************************************	

2655 Park Center Drive, Suite A								
Simi Valley, California 93065	Requested Turnarou	nd Time in Busine	ess Days (Surc	harges) please (circle <	\ \	CAS Project N	0. 0.4047_
Phone (805) 526-7161	1 Day (100%) 2 Day ((75%) 3 Day (50%) 4 Day (35%)	5 Day (25%)(10	Day-Stand:	ard / CAS Contact		0.707
Fax (805) 526-7270						CAS Contact		no produce de la companya del companya de la companya del companya de la companya
Company Name & Address (Reporting Information) Aquatella Environmental Salutions Inc 13 Executive Dr. Suite 1	Project Name	4737.11	2012	Flore Tes	FIRM	Analysis	Method	
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13 Executive Dr. Jane	Project Number	4733.11					M	
Failview Heights IL 62208	P.O. # / Billing Informa	ation				٤	350	Comments
Project Manager Tim Pool						35	9178 3010	e.g. Actual
Phone Fax							1 W 12	Preservative or
618-628-2001 618-628-2002	1 (Division)					3 00 E	The The	specific instructions
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Email Address for Result Reporting +pool @ aquateria - env.com	0	Flow Controller ID	Canister	Canister		₹. %	NMOC Sthes 1	
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Client Sample ID ID Number Collected Collected	AC, SC, etc.)	FC #)	"Hg	"Hg/psig	Volume	 	 	
CLUB CULL HU DI 2010-1-12 1405	15600442	AUG 02580	-27			X	X	
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Report Tier Levels - please select Tier I - Results (Default if not specified) Tier III (Re	suits + QC & Calibration Su	ımmaries)				quired Yes /	No .	Project Requirements (MRLs, QAPP)
Tier If (Results + QC Summaries) Tier IV (Da	ta Validation Package) 10%	6 Surcharge			Type:			J
Date:	Time:	Received by: (Sign	atu(4) \ O .			1996 /	Time:	-
Relinquished by: (Signature)	2 1600		LETT 1	000		1771	Time:	Cooler / Blank
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Now	part of the ALS	iraup	Samp	le Acceptance	Check Form	n				
		vironmental Solutions			2	Work order:	P1204087			
	Cottonwood F s) received on:	Hills 2012 Flare Testin	ng / 4733.11		Data ananad:	10/4/12	hvv	MZAN	IOD A	
		samples received by CAS.	The use of this fo	■3	Date opened:		by:	MZAN		
		Thermal preservation and							anon or	
лирианее ч	or noncomorning.	Thermal preservation and	pii wiii oiliy be ev	ardated either at ti	ic request or the	enent and/or as require	d by the method	Yes	<u>No</u>	<u>N/A</u>
1	Were sample containers properly marked with client sample ID?									
2	Container(s) s	supplied by CAS?						X		
3	Did sample co	ontainers arrive in go	od condition?					X		
4	Were chain-o	f-custody papers used	l and filled ou	t?				X		
5		ontainer labels and/o			pers?			X		
6	-	olume received adeq						X		
7	_	vithin specified holdi	-					X		
8	-	emperature (thermal	•	of cooler at rec	eipt adhered	to?				X
	1				1					
9	Was a trip bla	ank received?							X	
10		seals on outside of c	ooler/Box?						X	
		Location of seal(s)?					Sealing Lid?			×
	Were signatur	e and date included?								×
	Were seals int									×
		seals on outside of sa	mple containe	er?					×	
	Trefe Castoay	Location of seal(s)?	_				Sealing Lid?			$\overline{\times}$
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	Were seals int									X
11		rs have appropriate p	reservation a	ccording to me	ethod/SOP or	Client specified i	nformation?			X
		nt indication that the		-		enem speemed i	inormation:			X
		ials checked for present			reserveu.					\boxtimes
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12	Tubes:	Are the tubes cap	•	l.f						
	D 1	Do they contain i		1 11						X
13	Badges:	Are the badges p								X
		Are dual bed bad	ges separated	and individual	ly capped and	d intact?				X
Lab	Sample ID	Container	Required	Received	Adjusted	VOA Headspace	Recei	pt / Prese	ervation	
		Description	pH *	pН	pН	(Presence/Absence)		Commei	nts	
1204087	7-001.01	1.0 L Source Can								
	7-002.01	1.0 L Source Can								
1204087	7-003.01	1.0 L Source Can								
Explain	any discrepanci	ies: (include lab sample	ID numbers):							
T										
	FEDD HCI (pH<2): I	RSK - CO2, (pH 5-8); Sulfur (1	H>4)							







Page 1 of 1

Client: Aquaterra Environmental Solutions, Inc.

Client Sample ID: CWH #4 CAS Project ID: P1204087 Client Project ID: Cottonwood Hills 2012 Flare Testing / 4733.11 CAS Sample ID: P1204087-001

Test Code: ASTM D3588-98

Analyst: Zheng Wang/Wade Henton/Jennifer Young Date Collected: 10/1/12 Sampling Media: 1.0 L Summa Canister Date Received: 10/4/12

Test Notes:

Container ID: 1SC00442

> Initial Pressure (psig): -0.98 Final Pressure (psig): 6.52

		Canister Dilution 1	Canister Dilution Factor: 1.55		
Components	Result	Result	Data		
-	Volume %	Weight %	Qualifie		
Hydrogen	0.66	0.05	100		
Oxygen + Argon	1.14	1.30			
Nitrogen	13.09	13.07			
Carbon Monoxide	< 0.01	< 0.01			
Methane	48.21	27.56			
Carbon Dioxide	36.80	57.73			
Hydrogen Sulfide	< 0.01	< 0.01			
Ethane	< 0.01	< 0.01			
Propane	< 0.01	0.01			
Butanes	< 0.01	0.01			
Pentanes	0.02	0.04			
Hexanes	0.01	0.04			
> Hexanes	0.04	0.18			
TOTALS	99.99	99.99			
Components	Mole %	Weight %			
Carbon	22.31	36.59			
Hydrogen	51.04	7.03			
Oxygen + Argon	19.81	43.30			
Nitrogen	6.84	13.08			
Sulfur	< 0.10	< 0.10			
Specific Gravity (Air = 1)		0.9687			
Specific Volume	ft3/lb	13.53			
Gross Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/ft3	494.9			
Net Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/ft3	445.6			
Gross Heating Value (Water Saturated at 0.25636 psia)	BTU/ft3	484.9			
Net Heating Value (Water Saturated at 0.25636 psia)	BTU/ft3	436.6			
Gross Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/lb	6,693.2			
Net Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/lb	6,026.5			
Compressibility Factor "Z" (60 F, 14.696 psia)		0.9973			





Page 1 of 1

Client: Aquaterra Environmental Solutions, Inc.

Client Sample ID: CWH #5 CAS Project ID: P1204087 Client Project ID: Cottonwood Hills 2012 Flare Testing / 4733.11 CAS Sample ID: P1204087-002

Test Code: ASTM D3588-98

Analyst: Zheng Wang/Wade Henton/Jennifer Young Date Collected: 10/1/12 Sampling Media: 1.0 L Summa Canister Date Received: 10/4/12

Test Notes:

Container ID: 1SC00388

> Initial Pressure (psig): -1.47 Final Pressure (psig): 5.34

		Canister Dilution 1	Factor: 1.51
Components	Result	Result	Data
-	Volume %	Weight %	Qualifie
Hydrogen	0.66	0.05	
Oxygen + Argon	1.11	1.27	
Nitrogen	12.99	12.97	
Carbon Monoxide	< 0.01	< 0.01	
Methane	48.28	27.60	
Carbon Dioxide	36.86	57.81	
Hydrogen Sulfide	< 0.01	< 0.01	
Ethane	< 0.01	< 0.01	
Propane	< 0.01	0.01	
Butanes	< 0.01	0.01	
Pentanes	0.02	0.04	
Hexanes	0.01	0.04	
> Hexanes	0.04	0.18	
TOTALS	99.99	99.99	
Components	Mole %	Weight %	
Carbon	22.32	36.65	
Hydrogen	51.08	7.04	
Oxygen + Argon	19.81	43.33	
Nitrogen	6.78	12.98	
Sulfur	< 0.10	< 0.10	
Specific Gravity (Air = 1)		0.9687	
Specific Volume	ft3/lb	13.53	
Gross Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/ft3	495.6	
Net Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/ft3	446.3	
Gross Heating Value (Water Saturated at 0.25636 psia)	BTU/ft3	485.7	
Net Heating Value (Water Saturated at 0.25636 psia)	BTU/ft3	437.3	
Gross Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/lb	6,703.6	
Net Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/lb	6,035.9	
Compressibility Factor "Z" (60 F, 14.696 psia)		0.9973	









Page 1 of 1

Client: Aquaterra Environmental Solutions, Inc.

Client Sample ID: CWH #6 CAS Project ID: P1204087 Client Project ID: Cottonwood Hills 2012 Flare Testing / 4733.11 CAS Sample ID: P1204087-003

Test Code: ASTM D3588-98

Analyst: Zheng Wang/Wade Henton/Jennifer Young Date Collected: 10/1/12 Sampling Media: 1.0 L Summa Canister Date Received: 10/4/12

Test Notes:

Container ID: 1SC00364

> Initial Pressure (psig): -1.59 Final Pressure (psig): 5.05

		Canister Dilution	Factor: 1.51	
Components	Result	Result	Data	
•	Volume %	Weight %	Qualifier	
Hydrogen	0.65	0.05		
Oxygen + Argon	1.49	1.69		
Nitrogen	14.21	14.18		
Carbon Monoxide	< 0.01	< 0.01		
Methane	47.39	27.08		
Carbon Dioxide	36.17	56.71		
Hydrogen Sulfide	< 0.01	< 0.01		
Ethane	< 0.01	< 0.01		
Propane	< 0.01	0.01		
Butanes	< 0.01	0.01		
Pentanes	0.02	0.04		
Hexanes	0.01	0.04		
> Hexanes	0.04	0.18		
TOTALS	99.99	99.99		
Components	Mole %	Weight %		
Carbon	22.11	35.95		
Hydrogen	50.59	6.90		
Oxygen + Argon	19.83	42.95		
Nitrogen	7.48	14.19		
Sulfur	< 0.10	< 0.10		
Specific Gravity (Air = 1)		0.9691		
Specific Volume	ft3/lb	13.52		
Gross Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/ft3	486.4		
Net Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/ft3	438.0		
Gross Heating Value (Water Saturated at 0.25636 psia)	BTU/ft3	476.7		
Net Heating Value (Water Saturated at 0.25636 psia)	BTU/ft3	429.2		
Gross Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/lb	6,576.1		
Net Heating Value (Dry Gas @ 60 F, 14.696 psia)	BTU/lb	5,921.0		
Compressibility Factor "Z" (60 F, 14.696 psia)		0.9973		



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RESULTS OF ANALYSIS

Page 1 of 1

Client: Aquaterra Environmental Solutions, Inc.

Client Sample ID: CWH #4 CAS Project ID: P1204087 Client Project ID: Cottonwood Hills 2012 Flare Testing / 4733.11 CAS Sample ID: P1204087-001

Test Code: EPA Method 3C Modified Date Collected: 10/1/12 HP5890 II/GC1/TCD Instrument ID: Date Received: 10/4/12 Analyst: Jennifer Young Date Analyzed: 10/5/12

Sampling Media: 1.0 L Summa Canister Volume(s) Analyzed: $0.10 \, \text{ml(s)}$

Test Notes:

Container ID: 1SC00442

Initial Pressure (psig): Final Pressure (psig): 6.52 -0.98

Canister Dilution Factor: 1.55

CAS#	Compound	Result %, v/v	MRL	Data Qualifier
			%, v/v	Qualifier
1333-74-0	Hydrogen	0.659	0.16	
7782-44-7	Oxygen +			
7440-37-1	Argon	1.14	0.16	
7727-37-9	Nitrogen	13.1	0.16	
630-08-0	Carbon Monoxide	ND	0.16	
74-82-8	Methane	48.2	0.16	
124-38-9	Carbon Dioxide	36.8	0.16	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.





Analytical Services*

RESULTS OF ANALYSIS

Page 1 of 1

Client: Aquaterra Environmental Solutions, Inc.

Client Sample ID: CWH #5 CAS Project ID: P1204087 Client Project ID: Cottonwood Hills 2012 Flare Testing / 4733.11 CAS Sample ID: P1204087-002

Test Code: EPA Method 3C Modified Date Collected: 10/1/12 HP5890 II/GC1/TCD Instrument ID: Date Received: 10/4/12 Analyst: Jennifer Young Date Analyzed: 10/5/12

Sampling Media: 1.0 L Summa Canister Volume(s) Analyzed: $0.10 \, \text{ml(s)}$

Test Notes:

Container ID: 1SC00388

> Initial Pressure (psig): Final Pressure (psig): 5.34 -1.47

> > Canister Dilution Factor: 1.51

CAS#	Compound	Result	MRL	Data
		%, v/v	%, v/v	Qualifier
1333-74-0	Hydrogen	0.658	0.15	
7782-44-7	Oxygen +			
7440-37-1	Argon	1.11	0.15	
7727-37-9	Nitrogen	13.0	0.15	
630-08-0	Carbon Monoxide	ND	0.15	
74-82-8	Methane	48.3	0.15	
124-38-9	Carbon Dioxide	36.9	0.15	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

Volume(s) Analyzed:

 $0.10 \, \text{ml(s)}$





RESULTS OF ANALYSIS

Page 1 of 1

Client: Aquaterra Environmental Solutions, Inc.

Client Sample ID: CWH #6 CAS Project ID: P1204087 Client Project ID: Cottonwood Hills 2012 Flare Testing / 4733.11 CAS Sample ID: P1204087-003

Test Code: EPA Method 3C Modified Date Collected: 10/1/12 HP5890 II/GC1/TCD Instrument ID: Date Received: 10/4/12 Analyst: Jennifer Young Date Analyzed: 10/5/12

Sampling Media:

Test Notes:

1.0 L Summa Canister

1SC00364

Container ID:

Initial Pressure (psig):

-1.59

Final Pressure (psig):

5.05

Canister Dilution Factor: 1.51

CAS#	Compound	Result %, v/v	MRL %, v/v	Data Qualifier
1333-74-0	Hydrogen	0.648	0.15	Quantities.
7782-44-7	Oxygen +			
7440-37-1	Argon	1.49	0.15	
7727-37-9	Nitrogen	14.2	0.15	
630-08-0	Carbon Monoxide	ND	0.15	
74-82-8	Methane	47.4	0.15	
124-38-9	Carbon Dioxide	36.2	0.15	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.





RESULTS OF ANALYSIS

Page 1 of 1

Client: Aquaterra Environmental Solutions, Inc.

Client Sample ID: Method Blank CAS Project ID: P1204087 Client Project ID: Cottonwood Hills 2012 Flare Testing / 4733.11 CAS Sample ID: P121005-MB

Test Code: EPA Method 3C Modified Date Collected: NA HP5890 II/GC1/TCD Instrument ID: Date Received: NA Analyst: Jennifer Young Date Analyzed: 10/05/12

Sampling Media: 1.0 L Summa Canister Volume(s) Analyzed: $0.10 \, \text{ml(s)}$

CAS#	Compound	Result	MRL	Data
		%, v/v	$\%$, $_{ m V/V}$	Qualifier
1333-74-0	Hydrogen	NE	0.10	
7782-44-7	Oxygen +			
7440-37-1	Argon	ND	0.10	
7727-37-9	Nitrogen	ND	0.10	
630-08-0	Carbon Monoxide	ND	0.10	
74-82-8	Methane	ND	0.10	
124-38-9	Carbon Dioxide	ND	0.10	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.





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LABORATORY CONTROL SAMPLE SUMMARY

Page 1 of 1

Client: Aquaterra Environmental Solutions, Inc.

Client Sample ID: Lab Control Sample CAS Project ID: P1204087 Client Project ID: Cottonwood Hills 2012 Flare Testing / 4733.11 CAS Sample ID: P121005-LCS

Test Code: EPA Method 3C Modified Date Collected: NA HP5890 II/GC1/TCD Date Received: NA Instrument ID: Jennifer Young Date Analyzed: 10/05/12 Analyst:

Sampling Media: 1.0 L Summa Canister Volume(s) Analyzed: NA ml(s)

					CAS	
CAS#	Compound	Spike Amount	Result	% Recovery	Acceptance	Data
		ppmV	\mathbf{ppmV}		Limits	Qualifier
1333-74-0	Hydrogen	40,000	37,200	93	75-117	
7782-44-7	Oxygen +					
7440-37-1	Argon	50,000	50,000	100	85-111	
7727-37-9	Nitrogen	50,000	51,400	103	85-114	
630-08-0	Carbon Monoxide	50,000	51,000	102	85-119	
74-82-8	Methane	40,000	41,800	105	90-114	
124-38-9	Carbon Dioxide	50,000	47,800	96	84-113	





Page 1 of 1

Client: Aquaterra Environmental Solutions, Inc. Client Project ID: Cottonwood Hills 2012 Flare Testing / 4733.11

CAS Project ID: P1204087

Total Gaseous Nonmethane Organics (TGNMO) as Methane

Test Code:

EPA Method 25C Modified

Instrument ID:

HP5890 II/GC1/FID/TCA

Analyst: Sampling Media: Jennifer Young

1.0 L Summa Canister(s)

Date(s) Collected: 10/1/12

Date Received: 10/4/12 Date Analyzed: 10/5/12

Client Sample ID	CAS Sample ID	Canister Dilution Factor	Injection Volume ml(s)	Result ppmV	MRL ppmV	Data Qualifier
CWH #4	P1204087-001	1.55	0.50	4,900	1.6	
CWH #5	P1204087-002	1.51	0.50	5,500	1.5	
CWH #6	P1204087-003	1.51	0.50	5,200	1.5	
Method Blank	P121005-MB	1.00	0.50	ND	1.0	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.





LABORATORY CONTROL SAMPLE SUMMARY

Page 1 of 1

Client: Aquaterra Environmental Solutions, Inc.

Client Sample ID: Lab Control Sample CAS Project ID: P1204087 Client Project ID: Cottonwood Hills 2012 Flare Testing / 4733.11 CAS Sample ID: P121005-LCS

Test Code: EPA Method 25C Modified Date Collected: NA Instrument ID: HP5890 II/GC1/FID/TCA Date Received: NA Date Analyzed: 10/05/12 Jennifer Young Analyst:

Sampling Media: 1.0 L Summa Canister Volume(s) Analyzed: NA ml(s)

Test Notes:

				CAS	
Compound	Spike Amount	Result	% Recovery	Acceptance	Data
	ppmV	ppmV		Limits	Qualifier
Total Gaseous Nonmethane Organics (TGNMO) as Methane	124	118	95	71-136	

25C_ALL.XLT - Page No.: P1204087_25C_1210081455_SS.xls - LCS 15 of 16

2655 Park Center Drive, Suite A, Simi Valley, CA 93065 | 805.526.7161 | www.caslab.com

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LABORATORY DUPLICATE SUMMARY RESULTS

Page 1 of 1

Client: Aquaterra Environmental Solutions, Inc.

Client Sample ID: CWH #6 CAS Project ID: P1204087

Client Project ID: Cottonwood Hills 2012 Flare Testing / 4733.11 CAS Sample ID: P1204087-003DUP

Test Code: EPA Method 25C Modified Date Collected: 10/1/12 HP5890 II/GC1/FID/TCA Date Received: 10/4/12 Instrument ID: Analyst: Jennifer Young Date Analyzed: 10/5/12

Sampling Media: 1.0 L Summa Canister Volume(s) Analyzed: 0.50 ml(s)

Test Notes:

1SC00364 Container ID:

> Initial Pressure (psig): -1.59 Final Pressure (psig): 5.05

> > Canister Dilution Factor: 1.51

Duplicate Compound Sample Result Sample Result Average % RPD **RPD** Data Qualifier ppmV ppmV Limit Total Gaseous Nonmethane Organics (TGNMO) as Methane 4,940 5080 5,220 6 14

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

P1204087_25C_1210081455_SS.xls - Dup (3)

SULFUR COMPOUNDS ANALYSIS





Analytical Services

LABORATORY REPORT

February 9, 2012

Tim Pool Aquaterra Environmental Solutions, Inc. 13 Executive Dr., Suite 1 Fairview Heights, IL 62208

RE: Cottonwood Hills Flare Gas Sample / 4733.11

Dear Tim:

Enclosed are the results of the samples submitted to our laboratory on January 27, 2012. For your reference, these analyses have been assigned our service request number P1200302.

All analyses were performed according to our laboratory's NELAP and DoD-ELAP-approved quality assurance program. The test results meet requirements of the current NELAP and DoD-ELAP standards, where applicable, and except as noted in the laboratory case narrative provided. For a specific list of NELAP and DoD-ELAPaccredited analytes, refer to the certifications section at www.caslab.com. Results are intended to be considered in their entirety and apply only to the samples analyzed and reported herein.

Columbia Analytical Services, Inc. is certified by the California Department of Health Services, NELAP Laboratory Certificate No. 02115CA; Arizona Department of Health Services, Certificate No. AZ0694; Florida Department of Health, NELAP Certification E871020; New Jersey Department of Environmental Protection, NELAP Laboratory Certification ID #CA009; New York State Department of Health, NELAP NY Lab ID No: 11221; Oregon Environmental Laboratory Accreditation Program, NELAP ID: CA20007; The American Industrial Hygiene Association, Laboratory #101661; United States Department of Defense Environmental Laboratory Accreditation Program (DoD-ELAP), Certificate No. L10-3-R2; Pennsylvania Registration No. 68-03307; TX Commission of Environmental Quality, NELAP ID T104704413-11-2; Minnesota Department of Health, NELAP Certificate No. 362188; Washington State Department of Ecology, ELAP Lab ID: C946, State of Utah Department of Health, NELAP Certificate No. CA015272011-1; Los Angeles Department of Building and Safety, Approval No: TA00001. Each of the certifications listed above have an explicit Scope of Accreditation that applies to specific matrices/methods/analytes; therefore, please contact me for information corresponding to a particular certification.

If you have any questions, please call me at (805) 526-7161.

Respectfully submitted,

Columbia Analytical Services, Inc.

Sue Anderson Project Manager





Client: Aquaterra Environmental Solutions, Inc. CAS Project No:

P1200302

Project: Cottonwood Hills Flare Gas Sample / 4733.11

CASE NARRATIVE

The samples were received intact under chain of custody on January 27, 2012 and were stored in accordance with the analytical method requirements. The valve on sample CWH-1 (P1200302-001) was found to be open upon receipt at the laboratory. The valve was closed upon receipt and enough volume was present to analyze per client instruction. Please refer to the sample acceptance check form for additional information. The results reported herein are applicable only to the condition of the samples at the time of sample receipt.

Sulfur Analysis

The samples were analyzed for twenty sulfur compounds per ASTM D 5504-08 using a gas chromatograph equipped with a sulfur chemiluminescence detector (SCD). All compounds with the exception of hydrogen sulfide and carbonyl sulfide are quantitated against the initial calibration curve for methyl mercaptan.

The results of analyses are given in the attached laboratory report. All results are intended to be considered in their entirety, and Columbia Analytical Services, Inc. (CAS) is not responsible for utilization of less than the complete report.

Use of Columbia Analytical Services, Inc. (CAS) Name. Client shall not use CAS's name or trademark in any marketing or reporting materials, press releases or in any other manner ("Materials") whatsoever and shall not attribute to CAS any test result, tolerance or specification derived from CAS's data ("Attribution") without CAS's prior written consent, which may be withheld by CAS for any reason in its sole discretion. To request CAS's consent, Client shall provide copies of the proposed Materials or Attribution and describe in writing Client's proposed use of such Materials or Attribution. If CAS has not provided written approval of the Materials or Attribution within ten (10) days of receipt from Client, Client's request to use CAS's name or trademark in any Materials or Attribution shall be deemed denied. CAS may, in its discretion, reasonably charge Client for its time in reviewing Materials or Attribution requests. Client acknowledges and agrees that the unauthorized use of CAS's name or trademark may cause CAS to incur irreparable harm for which the recovery of money damages will be inadequate. Accordingly, Client acknowledges and agrees that a violation shall justify preliminary injunctive relief. For questions contact the laboratory.





DETAIL SUMMARY REPORT

Client: Aquaterra Environmental Solutions, Inc. Service Request: P1200302

Project ID: Cottonwood Hills Flare Gas Sample / 4733.11

Date Received: 1/27/2012 Time Received: 09:30

> Date Time

ASTM D5504-01 - Sulfur Bag Client Sample ID Lab Code Matrix Collected Collected CWH-1 P1200302-001 1/26/2012 13:05 X Air CWH-2 P1200302-002 Air 1/26/2012 13:10 Х CWH-3 P1200302-003 1/26/2012 13:15 X Air



Air - Chain of Custody Record & Analytical Service Request

-		
Page	of	

2655 Park Center Drive, Suite A Simi Valley, California 93065 Phone (805) 526-7161 Fax (805) 526-7270

Phone (805) 526-7161				Requested Turnard	ound Time in Busi	ness Days (Surc	harges) please	circle		CAS Project	No.	
Fax (805) 526-7270				1 Day (100%) 2 Day	y (75%) 3 Day (50°	6) 4 Day (35%)	5 Day (25%) 1	Day-Stand	dard	PI	100302	NO.
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-	Laboratory	Date	Time	Canister ID	Flow Controller ID	Canister	Canister		8 -			MEMbrin
Client Sample ID	ID Number	Collected	Collected	(Bar code # - AC, SC, etc.)	(Bar code #- FC #)	Start Pressure	End Pressure	Sample	457 X			A DAMAGE CONTRACT
CWH-1	(N) °	7 7/	1		10 #)	"Hg	"Hg/psig	Volume				4
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Report Tier Levels - please select					<u></u>							
Tier I - Results (Default if not specified)			Tier III (Results	s + QC & Calibration Sum	maries)			EDD			i	COLUMN TO SERVICE STATE OF THE
Tier II (Results + QC Summaries)			Tier IV (Data V	alidation Package) 10% S	Surcharge			Type:	red Yes / I		Project Requirements (MRLs, QAPP)	
Relinquished by: (Signature)			Date:	T		AA		7,			Tonites, State 1	
			1-2612	\$ MO	Received by: Signatu	WALIN	ll C		Pate:	Time: OG20		
Relinquished by: (Signature)		***************************************	Date:	<u> </u>	Received by: (Signatu	re)			Date:	Time:	Cooler / Blank	
					**	•					Temperature or	



Now	part of the ALS	iraup	Samul	le Acceptance	Check Forn	1				
Client:	Aquaterra Env	vironmental Solutions	_	и лесеріанес	CHCCK FUIL		P1200302			
		Hills Flare Gas Sample			•					
Sample(s) received on:	1/27/12			Date opened:	1/27/12	by:	MZAN	1ORA	
Note: This f	form is used for <u>all</u>	samples received by CAS.	The use of this for	rm for custody sea	ls is strictly mea	nt to indicate presence	absence and not	as an indic	ation of	
compliance	or nonconformity.	Thermal preservation and p	H will only be ev	aluated either at th	ne request of the	client and/or as require	ed by the method/		No	<u>N/A</u>
1	Wara samula	aantainang neonarly, r	norted with a	liant compla IT	N 9			<u>Yes</u>	<u>No</u> □	
1	-	containers properly 1 supplied by CAS?	narked with Ci	nem sample il	, ,			X		
2			ad aanditian?					X		
3	_	ontainers arrive in go		0						
4		f-custody papers used			0			X		
5	_	ontainer labels and/o			pers?			X		
6	-	volume received adequ	-	51S?				X		
7	-	vithin specified holdin	-	0 1		. 0		\boxtimes		
8	Was proper te	emperature (thermal _j	oreservation) (of cooler at rec	eipt adhered	to?				X
								_		
9	Was a trip bla		1 / 20 0							\boxtimes
10	Were custody	seals on outside of co					~		\boxtimes	
		Location of seal(s)?					Sealing Lid?			X
		e and date included?								X
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		Location of seal(s)?					Sealing Lid?			\boxtimes
		e and date included?								X
	Were seals int									\boxtimes
11		rs have appropriate pr		-		Client specified i	nformation?		旦	$\overline{\times}$
		nt indication that the			reserved?					×
	Were VOA v	ials checked for prese	nce/absence o	of air bubbles?						\times
	Does the clien	t/method/SOP require	_		ample pH and	d <u>if necessary</u> alte	er it?		Д	$\overline{\mathbf{X}}$
12	Tubes:	Are the tubes cap	ped and intact	.?						X
		Do they contain n	noisture?							X
13	Badges:	Are the badges p	roperly cappe	d and intact?						X
		Are dual bed bad	ges separated a	and individual	ly capped and	l intact?				X
Lab	Sample ID	Container	Required	Received	Adjusted	VOA Headspace	Recei	pt / Prese	rvation	
Lao.	Sumple 1D	Description	pH *	рН	pH	(Presence/Absence)		Comme		
P1200302	2-001 01	1 L Zefon Bag	•				Received Ted	lar hag v	vith valv	e open
P1200302		1 L Zefon Bag					recorred rea	iai oag ,	· rur · ur ·	Соры
P1200302	2-003.01	1 L Zefon Bag								
Е 1.			II) 1)			l				
Explain	any discrepanci	ies: (include lab sample	in numbers):							
RSK - MI	EEPP, HCL (pH<2); I	RSK - CO2, (pH 5-8); Sulfur (p	H>4)							

Date Collected: 1/26/12

Date Received: 1/27/12

Date Analyzed: 1/27/12

Time Collected: 13:05



Columbia



Analytical Services*

RESULTS OF ANALYSIS

Page 1 of 1

Client: Aquaterra Environmental Solutions, Inc.

Client Sample ID: CWH-1 CAS Project ID: P1200302 Client Project ID: Cottonwood Hills Flare Gas Sample / 4733.11 CAS Sample ID: P1200302-001

Test Code: ASTM D 5504-08

Agilent 6890A/GC13/SCD Instrument ID:

Wade Henton Analyst: Sampling Media: 1 L Zefon Bag Test Notes:

Time Analyzed: 11:38 Volume(s) Analyzed: 1.0 ml(s)

CAS#	Compound	Result	MRL	Result	MRL	Data
		$\mu \mathrm{g}/\mathrm{m}^3$	$\mu g/m^3$	ppbV	ppbV	Qualifier
7783-06-4	Hydrogen Sulfide	4,600	7.0	3,300	5.0	
463-58-1	Carbonyl Sulfide	57	12	23	5.0	
74-93-1	Methyl Mercaptan	1,900	9.8	980	5.0	
75-08-1	Ethyl Mercaptan	61	13	24	5.0	
75-18-3	Dimethyl Sulfide	7,600	13	3,000	5.0	
75-15-0	Carbon Disulfide	42	7.8	14	2.5	
75-33-2	Isopropyl Mercaptan	270	16	86	5.0	
75-66-1	tert-Butyl Mercaptan	560	18	150	5.0	
107-03-9	n-Propyl Mercaptan	44	16	14	5.0	
624-89-5	Ethyl Methyl Sulfide	99	16	32	5.0	
110-02-1	Thiophene	360	17	100	5.0	
513-44-0	Isobutyl Mercaptan	110	18	30	5.0	\mathbf{W}
352-93-2	Diethyl Sulfide	ND	18	ND	5.0	
109-79-5	n-Butyl Mercaptan	53	18	14	5.0	
624-92-0	Dimethyl Disulfide	130	9.6	33	2.5	
616-44-4	3-Methylthiophene	110	20	28	5.0	
110-01-0	Tetrahydrothiophene	ND	18	ND	5.0	
638-02-8	2,5-Dimethylthiophene	ND	23	ND	5.0	
872-55-9	2-Ethylthiophene	ND	23	ND	5.0	
110-81-6	Diethyl Disulfide	ND	12	ND	2.5	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method. W = Result quantified, but the corresponding peak was detected outside of generated retention time window.

Date Collected: 1/26/12

Time Collected: 13:10



Columbia



Analytical Services*

RESULTS OF ANALYSIS

Page 1 of 1

Client: Aquaterra Environmental Solutions, Inc.

Client Sample ID: CWH-2 CAS Project ID: P1200302 Client Project ID: Cottonwood Hills Flare Gas Sample / 4733.11 CAS Sample ID: P1200302-002

Test Code: ASTM D 5504-08

Agilent 6890A/GC13/SCD Instrument ID:

Wade Henton Analyst: Date Received: 1/27/12 Sampling Media: 1 L Zefon Bag Date Analyzed: 1/27/12 Test Notes:

Time Analyzed: 11:59 Volume(s) Analyzed: 1.0 ml(s)

CAS#	Compound	Result	MRL	Result	MRL	Data
		$\mu \mathrm{g}/\mathrm{m}^3$	$\mu g/m^3$	${\sf ppbV}$	ppbV	Qualifier
7783-06-4	Hydrogen Sulfide	22,000	7.0	16,000	5.0	
463-58-1	Carbonyl Sulfide	190	12	76	5.0	
74-93-1	Methyl Mercaptan	8,100	9.8	4,100	5.0	
75-08-1	Ethyl Mercaptan	250	13	97	5.0	
75-18-3	Dimethyl Sulfide	26,000	13	10,000	5.0	
75-15-0	Carbon Disulfide	130	7.8	43	2.5	
75-33-2	Isopropyl Mercaptan	920	16	300	5.0	
75-66-1	tert-Butyl Mercaptan	1,700	18	460	5.0	
107-03-9	n-Propyl Mercaptan	110	16	36	5.0	
624-89-5	Ethyl Methyl Sulfide	300	16	98	5.0	
110-02-1	Thiophene	1,200	17	350	5.0	
513-44-0	Isobutyl Mercaptan	370	18	100	5.0	\mathbf{W}
352-93-2	Diethyl Sulfide	39	18	11	5.0	
109-79-5	n-Butyl Mercaptan	190	18	52	5.0	
624-92-0	Dimethyl Disulfide	370	9.6	95	2.5	
616-44-4	3-Methylthiophene	400	20	99	5.0	
110-01-0	Tetrahydrothiophene	78	18	22	5.0	
638-02-8	2,5-Dimethylthiophene	51	23	11	5.0	
872-55-9	2-Ethylthiophene	49	23	11	5.0	
110-81-6	Diethyl Disulfide	ND	12	ND	2.5	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method. W = Result quantified, but the corresponding peak was detected outside of generated retention time window.



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RESULTS OF ANALYSIS

Page 1 of 1

Client: Aquaterra Environmental Solutions, Inc.

Client Sample ID: CWH-3 CAS Project ID: P1200302 Client Project ID: Cottonwood Hills Flare Gas Sample / 4733.11 CAS Sample ID: P1200302-003

Test Code: ASTM D 5504-08

Instrument ID:

Wade Henton Analyst: Sampling Media: 1 L Zefon Bag

Test Notes:

Date Collected: 1/26/12 Agilent 6890A/GC13/SCD Time Collected: 13:15 Date Received: 1/27/12 Date Analyzed: 1/27/12

Time Analyzed: 12:22

Volume(s) Analyzed: 1.0 ml(s)

CAS#	Compound	Result	MRL	Result	MRL	Data
		μg/m³	$\mu g/m^3$	${\sf ppbV}$	ppbV	Qualifier
7783-06-4	Hydrogen Sulfide	22,000	7.0	16,000	5.0	
463-58-1	Carbonyl Sulfide	190	12	76	5.0	
74-93-1	Methyl Mercaptan	7,600	9.8	3,900	5.0	
75-08-1	Ethyl Mercaptan	230	13	90	5.0	
75-18-3	Dimethyl Sulfide	25,000	13	9,800	5.0	
75-15-0	Carbon Disulfide	130	7.8	43	2.5	
75-33-2	Isopropyl Mercaptan	870	16	280	5.0	
75-66-1	tert-Butyl Mercaptan	1,500	18	420	5.0	
107-03-9	n-Propyl Mercaptan	100	16	32	5.0	
624-89-5	Ethyl Methyl Sulfide	270	16	86	5.0	
110-02-1	Thiophene	1,100	17	320	5.0	
513-44-0	Isobutyl Mercaptan	340	18	91	5.0	\mathbf{W}
352-93-2	Diethyl Sulfide	29	18	8.0	5.0	
109-79-5	n-Butyl Mercaptan	180	18	49	5.0	
624-92-0	Dimethyl Disulfide	320	9.6	83	2.5	
616-44-4	3-Methylthiophene	360	20	90	5.0	
110-01-0	Tetrahy drothiophene	65	18	18	5.0	
638-02-8	2,5-Dimethylthiophene	33	23	7.1	5.0	
872-55-9	2-Ethylthiophene	30	23	6.5	5.0	
110-81-6	Diethyl Disulfide	ND	12	ND	2.5	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method. W = Result quantified, but the corresponding peak was detected outside of generated retention time window.





Page 1 of 1

Client: Aquaterra Environmental Solutions, Inc.

Client Sample ID: Method Blank CAS Project ID: P1200302
Client Project ID: Cottonwood Hills Flare Gas Sample / 4733.11 CAS Sample ID: P120127-MB

Test Code: ASTM D 5504-08

Instrument ID: Agilent 6890A/GC13/SCD

Analyst: Wade Henton
Sampling Media: 1 L Zefon Bag

Test Notes: Time Analyzed: 08:22
Volume(s) Analyzed: 1.0 ml(s)

CAS#	Compound	ompound Result MRL		Result	MRL	Data
		$\mu \mathrm{g/m^3}$	μg/m³	ppbV	ppbV	Qualifier
7783-06-4	Hydrogen Sulfide	ND	7.0	ND	5.0	
463-58-1	Carbonyl Sulfide	ND	12	ND	5.0	
74-93-1	Methyl Mercaptan	ND	9.8	ND	5.0	
75-08-1	Ethyl Mercaptan	ND	13	ND	5.0	
75-18-3	Dimethyl Sulfide	ND	13	ND	5.0	
75-15-0	Carbon Disulfide	ND	7.8	ND	2.5	
75-33-2	Isopropyl Mercaptan	ND	16	ND	5.0	
75-66-1	tert-Butyl Mercaptan	ND	18	ND	5.0	
107-03-9	n-Propyl Mercaptan	ND	16	ND	5.0	
624-89-5	Ethyl Methyl Sulfide	ND	16	ND	5.0	
110-02-1	Thiophene	ND	17	ND	5.0	
513-44-0	Isobutyl Mercaptan	ND	18	ND	5.0	
352-93-2	Diethyl Sulfide	ND	18	ND	5.0	
109-79-5	n-Butyl Mercaptan	ND	18	ND	5.0	
624-92-0	Dimethyl Disulfide	ND	9.6	ND	2.5	
616-44-4	3-Methylthiophene	ND	20	ND	5.0	
110-01-0	Tetrahydrothiophene	ND	18	ND	5.0	
638-02-8	2,5-Dimethylthiophene	ND	23	ND	5.0	
872-55-9	2-Ethylthiophene	ND	23	ND	5.0	
110-81-6	Diethyl Disulfide	ND	12	ND	2.5	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

Date Collected: NA

Time Collected: NA

Date Received: NA

Date Analyzed: 1/27/12





LABORATORY CONTROL SAMPLE SUMMARY

Page 1 of 1

Client: Aquaterra Environmental Solutions, Inc.

Client Sample ID: Lab Control Sample CAS Project ID: P1200302 Client Project ID: Cottonwood Hills Flare Gas Sample / 4733.11 CAS Sample ID: P120127-LCS

Test Code: ASTM D 5504-08 Date Collected: NA

Agilent 6890A/GC13/SCD Date Received: NA Instrument ID: Wade Henton Date Analyzed: 1/27/12 Analyst:

Sampling Media: 1 L Zefon Bag Volume(s) Analyzed: NA ml(s)

				CAS					
CAS#	Compound	Spike Amount	Result	% Recovery	Acceptance	Data			
		ppbV	ppbV		Limits	Qualifier			
7783-06-4	Hydrogen Sulfide	2,380	1,780	75	51-141				
463-58-1	Carbonyl Sulfide	2,470	1,700	69	63-147				
74-93-1	Methyl Mercaptan	2,360	2,110	89	54-156				







Analytical Services*

Columbia

LABORATORY DUPLICATE SUMMARY RESULTS

Page 1 of 1

Client: Aquaterra Environmental Solutions, Inc.

Client Sample ID: CWH-3 CAS Project ID: P1200302

Client Project ID: Cottonwood Hills Flare Gas Sample / 4733.11 CAS Sample ID: P1200302-003DUP

Test Code: ASTM D 5504-08

Agilent 6890A/GC13/SCD Instrument ID:

Wade Henton Analyst: Sampling Media: 1 L Zefon Bag

Test Notes:

Date Collected: 1/26/12 Time Collected: 13:15 Date Received: 1/27/12 Date Analyzed: 1/27/12 Time Analyzed: 12:48

Volume(s) Analyzed: 1.0 ml(s)

				Dupli					
CAS#	Compound	Sample 1	Result	Sample Result		Average	% RPD	RPD	Data
		μg/m³	ppbV	μg/m³	ppbV	${f ppbV}$		Limit	Qualifier
7783-06-4	Hydrogen Sulfide	22,400	16,100	22,700	16,300	16200	1	34	
463-58-1	Carbonyl Sulfide	187	76.2	186	75.7	75.95	0.7	35	
74-93-1	Methyl Mercaptan	7,650	3,890	7,570	3,850	3870	1	41	
75-08-1	Ethyl Mercaptan	229	90.0	233	91.6	90.8	2	41	
75-18-3	Dimethyl Sulfide	25,000	9,830	24,500	9,650	9740	2	41	
75-15-0	Carbon Disulfide	133	42.7	123	39.6	41.15	8	41	
75-33-2	Isopropyl Mercaptan	870	280	861	277	278.5	1	41	
75-66-1	tert-Butyl Mercaptan	1,540	419	1,500	406	412.5	3	41	
107-03-9	n-Propyl Mercaptan	99.6	32.0	96.1	30.9	31.45	3	41	
624-89-5	Ethyl Methyl Sulfide	268	86.0	282	90.7	88.35	5	41	
110-02-1	Thiophene	1,090	318	1,050	305	311.5	4	41	
513-44-0	Isobutyl Mercaptan	336	91.2	342	92.7	91.95	2	41	\mathbf{W}
352-93-2	Diethyl Sulfide	29.4	7.97	40.0	10.9	9.435	31	41	
109-79-5	n-Butyl Mercaptan	180	48.7	182	49.5	49.1	2	41	
624-92-0	Dimethyl Disulfide	320	83.1	309	80.2	81.65	4	41	
616-44-4	3-Methylthiophene	362	90.3	350	87.3	88.8	3	41	
110-01-0	Tetrahydrothiophene	65.1	18.1	67.1	18.6	18.35	3	41	
638-02-8	2,5-Dimethylthiophene	32.6	7.10	38.8	8.45	7.775	17	41	
872-55-9	2-Ethylthiophene	29.9	6.51	38.0	8.28	7.395	24	41	
110-81-6	Diethyl Disulfide	ND	ND	ND	ND	-	-	41	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

W = Result quantified, but the corresponding peak was detected outside of generated retention time window.





LABORATORY REPORT

October 3, 2012

Analytical Services*

Tim Pool Aquaterra Environmental Solutions, Inc. 13 Executive Dr., Suite 1 Fairview Heights, IL 62208

RE: Cottonwood Hills 2012 Flare Sampling / 4733,11

Dear Tim:

Enclosed are the results of the samples submitted to our laboratory on October 2, 2012. For your reference, these analyses have been assigned our service request number P1204038.

All analyses were performed according to our laboratory's NELAP and DoD-ELAP-approved quality assurance program. The test results meet requirements of the current NELAP and DoD-ELAP standards, where applicable, and except as noted in the laboratory case narrative provided. For a specific list of NELAP and DoD-ELAP-accredited analytes, refer to the certifications section at www.caslab.com. Results are intended to be considered in their entirety and apply only to the samples analyzed and reported herein.

Columbia Analytical Services, Inc. dba ALS Environmental (ALS) is certified by the California Department of Health Services, NELAP Laboratory Certificate No. 02115CA; Arizona Department of Health Services, Certificate No. AZ0694; Florida Department of Health, NELAP Certification E871020; New Jersey Department of Environmental Protection, NELAP Laboratory Certification ID #CA009; New York State Department of Health, NELAP NY Lab ID No: 11221; Oregon Environmental Laboratory Accreditation Program, NELAP ID: CA200007; The American Industrial Hygiene Association, Laboratory #101661; United States Department of Defense Environmental Laboratory Accreditation Program (DoD-ELAP), Certificate No. L11-203; Pennsylvania Registration No. 68-03307; TX Commission of Environmental Quality, NELAP ID T104704413-12-3; Minnesota Department of Health, NELAP Certificate No. 362188; Washington State Department of Ecology, ELAP Lab ID: C946, State of Utah Department of Health, NELAP Certificate No. CA01527Z012-Z; Los Angeles Department of Building and Safety, Approval No: TA00001. Each of the certifications listed above have an explicit Scope of Accreditation that applies to specific matrices/methods/analytes; therefore, please contact me for information corresponding to a particular certification.

If you have any questions, please call me at (805) 526-7161.

Respectfully submitted,

ALS | Environmental

Sue Anderson Project Manager





Client Aguaterra Environmental Solutions, Inc. Service Request No: P1204038

Project: Cottonwood Hills 2012 Flare Sampling / 4733.11

CASE NARRATIVE

The samples were received intact under chain of custody on October 2, 2012 and were stored in accordance with the analytical method requirements. Please refer to the sample acceptance check form for additional information. The results reported herein are applicable only to the condition of the samples at the time of sample receipt.

Sulfur Analysis

The samples were analyzed for twenty sulfur compounds per ASTM D 5504-08 using a gas chromatograph equipped with a sulfur chemiluminescence detector (SCD). All compounds with the exception of hydrogen sulfide and carbonyl sulfide are quantitated against the initial calibration curve for methyl mercaptan.

The results of analyses are given in the attached laboratory report. All results are intended to be considered in their entirety, and Columbia Analytical Services, Inc. dba ALS Environmental (ALS) is not responsible for utilization of less than the complete report.

Use of Columbia Analytical Services, Inc. dba ALS Environmental (ALS)'s Name. Client shall not use ALS's name or trademark in any marketing or reporting materials, press releases or in any other manner ("Materials") whatsoever and shall not attribute to AALS any test result, tolerance or specification derived from ALS's data ("Attribution") without ALS's prior written consent, which may be withheld by ALS for any reason in its sole discretion. To request ALS's consent, Client shall provide copies of the proposed Materials or Attribution and describe in writing Client's proposed use of such Materials or Attribution. If ALS has not provided written approval of the Materials or Attribution within ten (10) days of receipt from Client, Client's request to use ALS's name or trademark in any Materials or Attribution shall be deemed denied. ALS may, in its discretion, reasonably charge Client for its time in reviewing Materials or Attribution requests. Client acknowledges and agrees that the unauthorized use of ALS's name or trademark may cause ALS to incur irreparable harm for which the recovery of money damages will be inadequate. Accordingly, Client acknowledges and agrees that a violation shall justify preliminary injunctive relief. For questions contact the laboratory.





DETAIL SUMMARY REPORT

Client: Aquaterra Environmental Solutions, Inc. Service Request: P1204038

Project ID: Cottonwood Hills 2012 Flare Sampling / 4733.11

Date Received: 10/2/2012 Time Received: 09:55

D5504-01 - Sulfur Bag

			Date	Time	MT
Client Sample ID	Lab Code	Matrix	Collected	Collected	AS.
CWH #1	P1204038-001	Air	10/1/2012	13:50	X
CWH #2	P1204038-002	Air	10/1/2012	13:55	X
CWH #3	P1204038-003	Air	10/1/2012	14:00	X



Air - Chain of Custody Record & Analytical Service Request

	rings			1	
Page		0	f	1	

2655 Park Center Drive, Suite A Simi Valley, California 93065 Phone (805) 526-7161

Fax (805) 526-7270				Requested Turnaro				The state of the s		CAS Project	204038
Company Name & Address (Reporting Information) Aquaters Environmental Solutions Inc. 13 Executive Or Swite I Fairview Heights IL 62208 Project Manager Phone 618-628-2001 Fax 618-628-2001 Email Address for Result Reporting +pood @ aquaterra-environ Client Sample ID Laboratory Date Collected Collected CWH #11 O 10-1-12 1350 CWH #12 Time				Project Name (oftenwood Hills 2012 Flare Sc-pling Project Number 1733. P.O. # / Billing Information					Analys 130550	is Method	Comments e.g. Actual Preservative or specific instructions
,	Laboratory	Date Collected	Time Collected	Canister ID (Bar code # - AC, SC, etc.)	Flow Controller ID (Bar code #- FC #)	Canister Start Pressure "Hg	Canister End Pressure "Hg/psig	Sample Volume	Astm total		
	2	10-1-12	1350	90675-54833	NA-		A CONTRACTOR OF THE PARTY OF TH		X		
•	3	J	1400	90675,54834 90675,54836					X		
									,		•
										·	
			70								
Report Tier Levels - please select Tier i - Results (Detault if not specified) Tier II (Results + QC Summaries)		<u> </u>		s + QC & Calibration Sun /alidation Package) 10%				EDD requi	ired Yes /	No	Project Requirements (MRLs, QAPP)
Relinquished by: (Signature)		7	Date: 10-1-12	Time: 600	Received by (Signal)	re) Atol	0000	1	17/1/c	Time:	
Relinquished by: (Signature)			Date:	Time:	Received by: (Signati	量しの人			Date:	Time.	Cooler / Blank



		vironmental Solutions	, Inc.	le Acceptance		Work order:	P1204038			
		Hills 2012 Flare Samp	ling / 4733.11							
	s) received on:			•	Date opened:		by:	MZAN		
		samples received by CAS.			•				cation of	
ompliance	or nonconformity.	Thermal preservation and J	oH will only be ev	aluated either at the	ie request of the	client and/or as requ	ired by the method	SOP. Yes	<u>No</u>	<u>N/A</u>
1	Were sample	containers properly 1	narked with cl	lient sample IF)?			$\overline{\mathbf{x}}$		
2	_	supplied by CAS?	narked with e	nent sample 12				×		
3		ontainers arrive in go	od condition?					×		
4	_	f-custody papers used						X		
					nore?			X		
5	Did sample container labels and/or tags agree with custody papers? Was sample volume received adequate for analysis?									
6	Are samples within specified holding times?									
7	-	•	-	.f. a. a.law at wa	المسملة مطالم	4.5.9				\boxtimes
8	Was proper temperature (thermal preservation) of cooler at receipt adhered to?									
0	Was a trin bl	amly magical da								X
9	Was a trip bla		lau/Daw?						\boxtimes	
10										\boxtimes
	Warn signatur						_ Sealing Lid?			\boxtimes
	Were seals int	re and date included?								\boxtimes
			mula containa	.m?					\boxtimes	
	were custody	seals on outside of sa	_				Caalina Lid9			\boxtimes
	Ware signatur	Location of seal(s)?					_ Sealing Lid?			X
	Were seals int	re and date included?								\boxtimes
11				aaandina ta ma	thod/COD on	Client enecifies	Linformation			X
11		rs have appropriate point indication that the		-		Chem specified	i ilitormation?			\boxtimes
		ials checked for prese			icscrvcu:					X
	-				ÎTT	1 :6	4 :40			
10		nt/method/SOP require	-		ampie pH and	i <u>ii necessary</u> ai	ter it?			X
12	Tubes:	Are the tubes cap								×
	_	Do they contain r								×
13	Badges:	Are the badges p						<u> </u>		×
		Are dual bed bad	ges separated a	and individual	y capped and	l intact?		<u> </u>		X
Lab	Sample ID	Container	Required	Received	Adjusted	VOA Headspac	e Recei	pt / Prese	ervation	
		Description	pH *	pН	pН	(Presence/Absenc	e)	Comme	nts	
P1204038	3-001,01	1 L Zefon Bag								
P1204038		1 L Zefon Bag								
P1204038	3-003.01	1 L Zefon Bag								
							+			
							+			
							<u> </u>			
Explair	any discrepanc	ies: (include lab sample	ID numbers):							
-		•								_
KSK - M	еврр, HCL (рН<2); l	RSK - CO2, (pH 5-8); Sulfur (p	m>4)							



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RESULTS OF ANALYSIS

Page 1 of 1

Client: Aquaterra Environmental Solutions, Inc.

Client Sample ID: CWH #1 CAS Project ID: P1204038 Client Project ID: Cottonwood Hills 2012 Flare Sampling / 4733.11 CAS Sample ID: P1204038-001

Test Code: ASTM D 5504-08

Agilent 6890A/GC13/SCD Instrument ID:

Wade Henton Analyst: Sampling Media: 1 L Zefon Bag

Test Notes:

Date Collected: 10/1/12 Time Collected: 13:50 Date Received: 10/2/12

Date Analyzed: 10/2/12 Time Analyzed: 10:24, 10:57

Volume(s) Analyzed: 1.0 ml(s)

 $0.010 \, \text{ml(s)}$

CAS#	Compound	Result	MRL	Result	MRL	Data
		$\mu g/m^3$	μg/m³	ppbV	ppbV	Qualifier
7783-06-4	Hydrogen Sulfide	850,000	700	610,000	500	D
463-58-1	Carbonyl Sulfide	5,300	12	2,200	5.0	
74-93-1	Methyl Mercaptan	20,000	9.8	10,000	5.0	
75-08-1	Ethyl Mercaptan	500	13	200	5.0	
75-18-3	Dimethyl Sulfide	24,000	13	9,500	5.0	
75-15-0	Carbon Disulfide	4,200	7.8	1,400	2.5	
75-33-2	Isopropyl Mercaptan	4,500	16	1,500	5.0	
75-66-1	tert-Butyl Mercaptan	1,300	18	350	5.0	
107-03-9	n-Propyl Mercaptan	270	16	88	5.0	
624-89-5	Ethyl Methyl Sulfide	200	16	64	5.0	
110-02-1	Thiophene	5,500	17	1,600	5.0	
513-44-0	Isobutyl Mercaptan	ND	18	ND	5.0	
352-93-2	Diethyl Sulfide	37	18	10	5.0	
109-79-5	n-Butyl Mercaptan	180	18	48	5.0	
624-92-0	Dimethyl Disulfide	570	9.6	150	2.5	
616-44-4	3-Methylthiophene	280	20	71	5.0	
110-01-0	Tetrahydrothiophene	81	18	22	5.0	
638-02-8	2,5-Dimethylthiophene	120	23	26	5.0	
872-55-9	2-Ethylthiophene	40	23	8. 7	5.0	
110-81-6	Diethyl Disulfide	ND	12	ND	2.5	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method. D = The reported result is from a dilution.



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RESULTS OF ANALYSIS

Page 1 of 1

Client: Aquaterra Environmental Solutions, Inc.

Client Sample ID: CWH #2 CAS Project ID: P1204038 Client Project ID: Cottonwood Hills 2012 Flare Sampling / 4733.11 CAS Sample ID: P1204038-002

Test Code: ASTM D 5504-08

Agilent 7890A/GC22/SCD Instrument ID:

Wade Henton Analyst: Sampling Media: 1 L Zefon Bag

Test Notes:

Date Collected: 10/1/12 Time Collected: 13:55

Date Received: 10/2/12 Date Analyzed: 10/2/12

Time Analyzed: 10:38, 10:56

Volume(s) Analyzed: 1.0 ml(s)

 $0.010 \, \text{ml(s)}$

CAS#	Compound	Result	MRL	Result	MRL	Data
		$\mu \mathrm{g}/\mathrm{m}^3$	μg/m³	ppbV	ppbV	Qualifier
7783-06-4	Hydrogen Sulfide	990,000	700	710,000	500	D
463-58-1	Carbonyl Sulfide	520	12	210	5.0	
74-93-1	Methyl Mercaptan	1,500	9.8	750	5.0	
75-08-1	Ethyl Mercaptan	41	13	16	5.0	
75-18-3	Dimethyl Sulfide	1,900	13	740	5.0	
75-15-0	Carbon Disulfide	330	7.8	110	2.5	
75-33-2	Isopropyl Mercaptan	360	16	120	5.0	
75-66-1	tert-Butyl Mercaptan	110	18	30	5.0	
107-03-9	n-Propyl Mercaptan	21	16	6.7	5.0	
624-89-5	Ethyl Methyl Sulfide	19	16	6.2	5.0	
110-02-1	Thiophene	400	17	110	5.0	
513-44-0	Isobutyl Mercaptan	ND	18	ND	5.0	
352-93-2	Diethyl Sulfide	ND	18	ND	5.0	
109-79-5	n-Butyl Mercaptan	ND	18	ND	5.0	
624-92-0	Dimethyl Disulfide	47	9.6	12	2.5	
616-44-4	3-Methylthiophene	22	20	5.4	5.0	
110-01-0	Tetrahydrothiophene	ND	18	ND	5.0	
638-02-8	2,5-Dimethylthiophene	ND	23	ND	5.0	
872-55-9	2-Ethylthiophene	ND	23	ND	5.0	
110-81-6	Diethyl Disulfide	ND	12	ND	2.5	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method. D = The reported result is from a dilution.



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RESULTS OF ANALYSIS

Page 1 of 1

Client: Aquaterra Environmental Solutions, Inc.

Client Sample ID: CWH #3 CAS Project ID: P1204038 Client Project ID: Cottonwood Hills 2012 Flare Sampling / 4733.11 CAS Sample ID: P1204038-003

Test Code: ASTM D 5504-08

Agilent 6890A/GC13/SCD Instrument ID:

Wade Henton Analyst: Sampling Media: 1 L Zefon Bag

Test Notes:

Date Collected: 10/1/12 Time Collected: 14:00 Date Received: 10/2/12 Date Analyzed: 10/2/12 Time Analyzed: 11:18, 11:38

Volume(s) Analyzed: 1.0 ml(s)

 $0.010 \, \text{ml(s)}$

CAS#	Compound	Result	MRL	Result	MRL	Data
		$\mu g/m^3$	μg/m³	${f ppbV}$	ppbV	Qualifier
7783-06-4	Hydrogen Sulfide	1,000,000	700	730,000	500	D
463-58-1	Carbonyl Sulfide	6,600	12	2,700	5.0	
74-93-1	Methyl Mercaptan	24,000	9.8	12,000	5.0	
75-08-1	Ethyl Mercaptan	590	13	230	5.0	
75-18-3	Dimethyl Sulfide	27,000	13	10,000	5.0	
75-15-0	Carbon Disulfide	4,600	7.8	1,500	2.5	
75-33-2	Isopropyl Mercaptan	5,200	16	1,700	5.0	
75-66-1	tert-Butyl Mercaptan	1,400	18	380	5.0	
107-03-9	n-Propyl Mercaptan	320	16	100	5.0	
624-89-5	Ethyl Methyl Sulfide	230	16	73	5.0	
110-02-1	Thiophene	6,100	17	1,800	5.0	-
513-44-0	Isobutyl Mercaptan	ND	18	ND	5.0	
352-93-2	Diethyl Sulfide	33	18	9.1	5.0	
109-79-5	n-Butyl Mercaptan	180	18	48	5.0	
624-92-0	Dimethyl Disulfide	580	9.6	150	2.5	
616-44-4	3-Methylthiophene	300	20	75	5.0	
110-01-0	Tetrahydrothiophene	80	18	22	5.0	
638-02-8	2,5-Dimethylthiophene	160	23	34	5.0	
872-55-9	2-Ethylthiophene	49	23	11	5.0	
110-81-6	Diethyl Disulfide	ND	12	ND	2.5	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method. D = The reported result is from a dilution.





RESULTS OF ANALYSIS

Page 1 of 1

Client: Aquaterra Environmental Solutions, Inc.

Client Sample ID: Method Blank
Client Project ID: Cottonwood Hills 2012 Flare Sampling / 4733.11
CAS Project ID: P1204038
CAS Sample ID: P121002-MB

Test Code: ASTM D 5504-08

Instrument ID: Agilent 6890A/GC13/SCD

Analyst: Wade Henton Sampling Media: 1 L Zefon Bag

Test Notes:

Time Collected: NA
Date Received: NA
Date Analyzed: 10/02/12
Time Analyzed: 07:56

Date Collected: NA

Volume(s) Analyzed: 1.0 ml(s)

CAS#	Compound	Result μg/m³	MRL μg/m³	Result ppbV	MRL ppbV	Data Qualifier
7783-06-4	Hydrogen Sulfide	ND	7.0	ND	5.0	Quantier
463-58-1	Carbonyl Sulfide	ND	12	ND	5.0	
74-93-1	Methyl Mercaptan	ND	9.8	ND	5.0	
75-08-1	Ethyl Mercaptan	ND	13	ND	5.0	
75-18-3	Dimethyl Sulfide	ND	13	ND	5.0	
75-15-0	Carbon Disulfide	ND	7.8	ND	2.5	
75-33-2	Isopropyl Mercaptan	ND	16	ND	5.0	
75-66-1	tert-Butyl Mercaptan	ND	18	ND	5.0	
107-03-9	n-Propyl Mercaptan	ND	16	ND	5.0	
624-89-5	Ethyl Methyl Sulfide	ND	16	ND	5.0	
110-02-1	Thiophene	ND	17	ND	5.0	
513-44-0	Isobutyl Mercaptan	ND	18	ND	5.0	
352-93-2	Diethyl Sulfide	ND	18	ND	5.0	
109-79-5	n-Butyl Mercaptan	ND	18	ND	5.0	
624-92-0	Dimethyl Disulfide	ND	9.6	ND	2.5	
616-44-4	3-Methylthiophene	ND	20	ND	5.0	
110-01-0	Tetrahydrothiophene	ND	18	ND	5.0	
638-02-8	2,5-Dimethylthiophene	ND	23	ND	5.0	
872-55-9	2-Ethylthiophene	ND	23	ND	5.0	
110-81-6	Diethyl Disulfide	ND	12	ND	2.5	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.



Analytical Services

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RESULTS OF ANALYSIS

Page 1 of 1

Client: Aquaterra Environmental Solutions, Inc.

Client Sample ID: Method Blank CAS Project ID: P1204038 Client Project ID: Cottonwood Hills 2012 Flare Sampling / 4733.11 CAS Sample ID: P121002-MB

Test Code: ASTM D 5504-08

Agilent 7890A/GC22/SCD Instrument ID:

Wade Henton Analyst: Sampling Media: 1 L Zefon Bag

Test Notes:

Date Collected: NA Time Collected: NA

Date Received: NA Date Analyzed: 10/02/12

Time Analyzed: 07:57

Volume(s) Analyzed: 1.0 ml(s)

CAS#	Compound	Result μg/m³	MRL μg/m³	Result ppbV	MRL ppbV	Data Qualifier
7783-06-4	Hydrogen Sulfide	ND	7.0	ND	5.0	Quantier
463-58-1	Carbonyl Sulfide	ND	12	ND	5.0	
74-93-1	Methyl Mercaptan	ND	9.8	ND	5.0	
75-08-1	Ethyl Mercaptan	ND	13	ND	5.0	
75-18-3	Dimethyl Sulfide	ND	13	ND	5.0	
75-15-0	Carbon Disulfide	ND	7.8	ND	2.5	
75-33-2	Isopropyl Mercaptan	ND	16	ND	5.0	
75-66-1	tert-Butyl Mercaptan	ND	18	ND	5.0	
107-03-9	n-Propyl Mercaptan	ND	16	ND	5.0	
624-89-5	Ethyl Methyl Sulfide	ND	16	ND	5.0	
110-02-1	Thiophene	ND	17	ND	5.0	
513-44-0	Isobutyl Mercaptan	ND	18	ND	5.0	
352-93-2	Diethyl Sulfide	ND	18	ND	5.0	
109-79-5	n-Butyl Mercaptan	ND	18	ND	5.0	
624-92-0	Dimethyl Disulfide	ND	9.6	ND	2.5	
616-44-4	3-Methylthiophene	ND	20	ND	5.0	
110-01-0	Tetrahydrothiophene	ND	18	ND	5.0	
638-02-8	2,5-Dimethylthiophene	ND	23	ND	5.0	
872-55-9	2-Ethylthiophene	ND	23	ND	5.0	
110-81-6	Diethyl Disulfide	ND	12	ND	2.5	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.



Now part of the ALS Group

LABORATORY CONTROL SAMPLE SUMMARY

Page 1 of 1

Client: Aquaterra Environmental Solutions, Inc.

Client Sample ID: Lab Control Sample CAS Project ID: P1204038 Client Project ID: Cottonwood Hills 2012 Flare Sampling / 4733.11 CAS Sample ID: P121002-LCS

Test Code: ASTM D 5504-08 Date Collected: NA

Agilent 6890A/GC13/SCD Date Received: NA Instrument ID: Wade Henton Date Analyzed: 10/02/12 Analyst:

Sampling Media: 1 L Zefon Bag Volume(s) Analyzed: NA ml(s)

Test Notes:

					CAS	
CAS#	Compound	Spike Amount	Result	% Recovery	Acceptance	Data
		ppbV	${f ppbV}$		Limits	Qualifier
7783-06-4	Hydrogen Sulfide	2,380	2,730	115	51-141	
463-58-1	Carbonyl Sulfide	2,470	2,200	89	63-147	
74-93-1	Methyl Mercaptan	2,360	3,240	137	54-156	





LABORATORY CONTROL SAMPLE SUMMARY

Page 1 of 1

Client: Aquaterra Environmental Solutions, Inc.

Client Sample ID: Lab Control Sample CAS Project ID: P1204038 Client Project ID: Cottonwood Hills 2012 Flare Sampling / 4733.11 CAS Sample ID: P121002-LCS

Test Code: ASTM D 5504-08 Date Collected: NA

Agilent 7890A/GC22/SCD Date Received: NA Instrument ID: Wade Henton Date Analyzed: 10/02/12 Analyst:

Sampling Media: 1 L Zefon Bag Volume(s) Analyzed: NA ml(s)

Test Notes:

					CAS	
CAS#	Compound	Spike Amount	Result	% Recovery	Acceptance	Data
		ppbV	ppbV		Limits	Qualifier
7783-06-4	Hydrogen Sulfide	2,380	2,700	113	51-141	
463-58-1	Carbonyl Sulfide	2,470	2,310	94	63-147	
74-93-1	Methyl Mercaptan	2,360	3,210	136	54-156	

APPENDIX C
CALCULATIONS



Waste Management, Inc. Cottonwood Hills Recycling and Disposal Facility Marissa, Illinois

Input

Sample No. **CWH-4**Date Collected 1/26/2012

Percent Methane: 51.2 Percent Net heat of combustion of methane* 802 KJ/g mole

Net Heating Value calculated using the following equation:

HT = K ∑CiHi

where:

H (T): Net Heating Value in (MJ/scm) at 25 deg. C, 760 mm Hg

K: 1.740x10⁻⁷ (1/ppm)(g mole/scm)(MJ/kcal)

where (g mole/scm) is at 20 deg. C

Ci: concentration of component sample component i in ppm

Hi: net heat of combustion for sample component i

in (kcal/g mole) at 25 deg. C, 760 mm Hg

Convert Heat of Combustion from Btu/scf to kcal/g mole

A) KJ/mol to J/mol

(802 kJ/g mole)*(1000 J/1 kJ) = 802,000 J/g mole

B) J/mole to cal/mole

(802,000 J/g mole)*(1 cal/4.184 J)= 191,682.6 cal/g mole

C) cal/mole to Kcal/mole

(191,682 cal/g mole)*(1 Kcal/1000 cal)= 191.7 kcal/g mole

Now calculate Net Heating Value

HT = K ∑CiHi

 $H(T) = 1.740 \times 10-7 (1/ppm)(g mole/scm)(MJ/kcal) \times 512000 ppm \times 191.7 kcal/g-mole$

H(T) = 17.08 MJ/scm

^{*} Value from Chemistry: The Central Science 2nd Edition, by Theodore L. Brown and H. Eugene LeMay, Jr.

Waste Management, Inc. Cottonwood Hills Recycling and Disposal Facility Marissa, Illinois

Input

Sample No. **CWH-5**Date Collected 1/26/2012

Percent Methane: 53.5 Percent
Net heat of combustion of methane* 802 KJ/g mole

Net Heating Value calculated using the following equation:

HT = K ∑CiHi

where:

H (T): Net Heating Value in (MJ/scm) at 25 deg. C, 760 mm Hg

K: 1.740x10⁻⁷ (1/ppm)(g mole/scm)(MJ/kcal)

where (g mole/scm) is at 20 deg. C

Ci: concentration of component sample component i in ppm

Hi: net heat of combustion for sample component i in (kcal/g mole) at 25 deg. C, 760 mm Hg

Convert Heat of Combustion from Btu/scf to kcal/g mole

A) KJ/mol to J/mol

(802 kJ/g mole)*(1000 J/1 kJ) = 802,000 J/g mole

B) J/mole to cal/mole

(802,000 J/g mole)*(1 cal/4.184 J)= 191,682.6 cal/g mole

C) cal/mole to Kcal/mole

(191,682 cal/g mole)*(1 Kcal/1000 cal)= 191.7 kcal/g mole

Now calculate Net Heating Value

HT = K ∑CiHi

 $H(T) = 1.740 \times 10-7 (1/ppm)(g \text{ mole/scm})(MJ/kcal) \times 535000 ppm \times 191.7 kcal/g-mole$

H(T) = 17.85 MJ/scm

^{*} Value from Chemistry: The Central Science 2nd Edition, by Theodore L. Brown and H. Eugene LeMay, Jr.

Waste Management, Inc.
Cottonwood Hills Recycling and Disposal Facility
Marissa, Illinois

Input

Sample No. CWH-6

Percent Methane: 52 Percent
Net heat of combustion of methane* 802 KJ/g mole

Net Heating Value calculated using the following equation:

HT = K ∑CiHi

where:

H (T): Net Heating Value in (MJ/scm) at 25 deg. C, 760 mm Hg

K: 1.740x10⁻⁷ (1/ppm)(g mole/scm)(MJ/kcal)

where (g mole/scm) is at 20 deg. C

Ci: concentration of component sample component i in ppm

Hi: net heat of combustion for sample component i

in (kcal/g mole) at 25 deg. C, 760 mm Hg

Convert Heat of Combustion from Btu/scf to kcal/g mole

A) KJ/mol to J/mol

(802 kJ/g mole)*(1000 J/1 kJ) = 802,000 J/g mole

B) J/mole to cal/mole

(802,000 J/g mole)*(1 cal/4.184 J)= 191,682.6 cal/g mole

C) cal/mole to Kcal/mole

(191,682 cal/g mole)*(1 Kcal/1000 cal)= 191.7 kcal/g mole

Now calculate Net Heating Value

HT = K ∑CiHi

 $H(T) = 1.740 \times 10-7 (1/ppm)(g mole/scm)(MJ/kcal) \times 520000 ppm \times 191.7 kcal/g-mole$

H(T) = 17.35 MJ/scm

^{*} Value from Chemistry: The Central Science 2nd Edition, by Theodore L. Brown and H. Eugene LeMay, Jr.

AQUATERRA ENVIRONMENTAL SOLUTIONS, INC.

NET HEATING VALUE CALCULATIONS

Waste Management, Inc.
Cottonwood Hills Recycling and Disposal Facility
Marissa, Illinois

Input

Sample No. **CWH #4**Date Collected: 10/1/2012

Percent Methane: 48.2 Percent
Net heat of combustion of methane* 802 KJ/g mole

Net Heating Value calculated using the following equation:

HT = K ∑CiHi

where:

H (T): Net Heating Value in (MJ/scm) at 25 deg. C, 760 mm Hg

K: 1.740x10⁻⁷ (1/ppm)(g mole/scm)(MJ/kcal)

where (g mole/scm) is at 20 deg. C

Ci: concentration of component sample component i in ppm

Hi: net heat of combustion for sample component i

in (kcal/g mole) at 25 deg. C, 760 mm Hg

Convert Heat of Combustion from Btu/scf to kcal/g mole

A) KJ/mol to J/mol

(802 kJ/g mole)*(1000 J/1 kJ) = 802,000 J/g mole

B) J/mole to cal/mole

(802,000 J/g mole)*(1 cal/4.184 J)= 191,682.6 cal/g mole

C) cal/mole to Kcal/mole

(191,682 cal/g mole)*(1 Kcal/1000 cal)= 191.7 kcal/g mole

Now calculate Net Heating Value

HT = K ∑CiHi

 $H(T) = 1.740 \times 10-7 (1/ppm)(g mole/scm)(MJ/kcal) \times 482000 ppm \times 191.7 kcal/g-mole$

H(T) = 16.08 MJ/scm

^{*} Value from Chemistry: The Central Science 2nd Edition, by Theodore L. Brown and H. Eugene LeMay, Jr.

Waste Management, Inc.
Cottonwood Hills Recycling and Disposal Facility
Marissa, Illinois

Input	
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Sample No. **CWH #5**Date Collected: 10/1/2012

Percent Methane: 48.3 Percent Net heat of combustion of methane* 802 KJ/g mole

Net Heating Value calculated using the following equation:

HT = K ∑CiHi

where:

H (T): Net Heating Value in (MJ/scm) at 25 deg. C, 760 mm Hg

K: 1.740x10⁻⁷ (1/ppm)(g mole/scm)(MJ/kcal)

where (g mole/scm) is at 20 deg. C

Ci: concentration of component sample component i in ppm

Hi: net heat of combustion for sample component i

in (kcal/g mole) at 25 deg. C, 760 mm Hg

Convert Heat of Combustion from Btu/scf to kcal/g mole

A) KJ/mol to J/mol

(802 kJ/g mole)*(1000 J/1 kJ) = 802,000 J/g mole

B) J/mole to cal/mole

(802,000 J/g mole)*(1 cal/4.184 J)= 191,682.6 cal/g mole

C) cal/mole to Kcal/mole

(191,682 cal/g mole)*(1 Kcal/1000 cal)= 191.7 kcal/g mole

Now calculate Net Heating Value

HT = K ∑CiHi

 $H(T) = 1.740 \times 10-7 (1/ppm)(g mole/scm)(MJ/kcal) \times 483000 ppm \times 191.7 kcal/g-mole$

H(T) = 16.11 MJ/scm

^{*} Value from Chemistry: The Central Science 2nd Edition, by Theodore L. Brown and H. Eugene LeMay, Jr.

Waste Management, Inc.
Cottonwood Hills Recycling and Disposal Facility
Marissa, Illinois

Input

Sample No. **CWH #6**Date Collected: 10/1/2012

Percent Methane: 47.4 Percent
Net heat of combustion of methane* 802 KJ/g mole

Net Heating Value calculated using the following equation:

HT = K ∑CiHi

where:

H (T): Net Heating Value in (MJ/scm) at 25 deg. C, 760 mm Hg

K: 1.740x10⁻⁷ (1/ppm)(g mole/scm)(MJ/kcal)

where (g mole/scm) is at 20 deg. C

Ci: concentration of component sample component i in ppm

Hi: net heat of combustion for sample component i in (kcal/g mole) at 25 deg. C, 760 mm Hg

Convert Heat of Combustion from Btu/scf to kcal/g mole

A) KJ/mol to J/mol

(802 kJ/g mole)*(1000 J/1 kJ) = 802,000 J/g mole

B) J/mole to cal/mole

(802,000 J/g mole)*(1 cal/4.184 J)= 191,682.6 cal/g mole

C) cal/mole to Kcal/mole

(191,682 cal/g mole)*(1 Kcal/1000 cal)= 191.7 kcal/g mole

Now calculate Net Heating Value

HT = K ∑CiHi

 $H(T) = 1.740 \times 10-7 (1/ppm)(g mole/scm)(MJ/kcal) \times 474000 ppm \times 191.7 kcal/g-mole$

H(T) = 15.81 MJ/scm

^{*} Value from Chemistry: The Central Science 2nd Edition, by Theodore L. Brown and H. Eugene LeMay, Jr.